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ANNALS *of* SURGERY

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No. 1

TREATMENT OF FRACTURES OF THE NECK OF THE FEMUR*

By A. BRUCE GILL, M.D.

OF PHILADELPHIA, PA.

A CLOSE study of the statistics pertaining to the treatment of fractures of the neck of the femur available in the literature very quickly reveals that a rigid comparison of the results obtained by various methods of treatment by different surgeons and in different clinics is not possible. Results are not tabulated in a uniform fashion. The cases in some series were apparently selected and in others included all that came to the hospital or the clinic. This fact alone must make a great difference in the percentage rate of the mortality and the end-results of treatment. The term "good functional result" may not always mean the same thing. Percentage of bony union is not often given.

Extracapsular, or intertrochanteric, fractures must be excluded, as it is well known that with proper treatment they always unite.

The age of the patient at the time of the fracture is of great importance. Union occurs much more frequently under sixty years than it does beyond this age. A fair comparison of the end-results of different methods of treatment is impossible unless the statistics permit us to divide the cases into at least these two groups.

But age is not the only consideration in the probability of union. While fractures of the femoral neck are rare in the young and common in the aged, why do some fractures unite and others not unite in individuals of the same age treated by the same method? Bone degenerative processes occur in the head and the neck of the femur with advancing years, or for other reasons, which increase the fragility of the bone and render repair more difficult. We frequently see evidences of a degenerative arthritis of the hip developing after a fracture. Is it not probable that these processes had already begun before the fracture occurred and that they have a direct etiological bearing on it.

It would be of interest if surgeons and röntgenologists would make note of such conditions present at the time of fracture.

Causes of Non-Union.—Before we can evaluate any method of treatment we should have some knowledge of the factors which tend to promote or prevent union of a fracture of the femoral neck.

(1) *Incomplete Reduction of the Fracture.*—One of the most frequent causes of non-union (omitting the consideration of those too frequent cases

* Read before the Philadelphia Academy of Surgery, November 2, 1931.

where no reduction at all has been made) is the interposition of soft parts between the fragments. Schmorl states that interposition of synovia prevented union in 75 per cent. of his cases. Wilson made a careful dissection in nine cases of non-union and found interposition of soft tissue in eight of them. In five, the capsule was adherent to the anteverted raw surface of the distal fragment; in two, it was densely bound to the distal portion of the proximal fragment; and in one, it was constricted between the fragments. Campbell mentions that the psoas tendon may be caught between the fragments. The author has repeatedly in his operations on old ununited fractures found the capsule adherent to the fractured surface of the proximal fragment, particularly at its inferior aspect, and frequently also adherent to the distal fractured surface.

Furthermore, on manipulation of a fractured hip there is a tendency for the short proximal fragment to rotate in the acetabulum. There is nothing to fix it.

(2) *Injury to Blood-supply with Necrosis of the Head.*—The main blood-supply to the head is derived from the capsular arteries which enter the base of the neck. It has been commonly believed that the ligamentum teres carries small vessels to the head in early life but that these vessels disappear after growth is attained. Recently, Schmorl and others have shown in serial sections of the ligamentum teres that the vessels are at times active even in old age. But it is conceded that these small vessels may be insufficient to nourish the femoral head when the vessels that enter it from the neck have been cut off by a fracture.

An injected specimen (*Acta Orthopædica Scandinavica*, vol. i, p. 3, 1930) demonstrates beautifully the arteries coursing through the neck apparently largely just beneath the periosteum and synovia and entering the head and anastomosing there, but it fails to show any penetrating the head in the region of the round ligament. The author has many times cut the ligamentum teres in operations for fracture of the neck of the femur and in operations for congenital dislocation of the hip, and he has never noticed any blood coming from either end of it. On removing the head in cases of non-union he has frequently observed that the round ligament is much degenerated. It is yellow and soft.

It seems probable, therefore, that at the time of the fracture the proximal fragment immediately is completely or almost completely deprived of its blood-supply. Of course, it must undergo death and aseptic necrosis unless the blood-supply becomes reëstablished. Impaction either by the force of the accident or by the surgeon at the time of reduction probably aids in early entrance of new vessels into the proximal fragment. Interposition of soft tissue or separation of the fragments prevents it. Possibly the head in some cases of old fracture has been receiving partial nourishment through the capsule which has become adherent to it.

But, certain it is, that in many cases of non-union the head is dead and is undergoing necrotic changes. This is demonstrable in the X-ray films.

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Such a head is relatively more dense than the bone of the distal fragment. As pointed out by Santos and Phemister, the distal fragment undergoes an atrophy of disuse and some of its lime salts are carried away in the bloodstream. The lime salts in the proximal fragment cannot be carried away because there is no circulation in it. The head, therefore, retains its original density in the X-ray film for a period of many months.

(3) *Absence of Normal Osteogenesis.*—What are the conditions which determine union or non-union following the fracture of any bone, and to what extent are these conditions present or absent in fractures of the neck of the femur?

When a fracture occurs in the shaft of a long bone, according to Leriche, there is first a congestion of the soft tissues about the fracture, a slowing down of the blood-supply, then a deposit in these tissues of a pre-osseous substance, followed by a conversion of this pre-osseous material into callus through the deposition of lime salts. He was unable to determine the biochemical process through which this conversion occurs. Recent laboratory studies seem to throw some light on this obscure process. An enzyme, called phosphatase, found in bones, in the kidney and elsewhere, appears to play the rôle of workman in using the materials furnished by the blood—namely, calcium and phosphorus—to construct bone. Studies now being made show that the amount of phosphatase varies greatly in conditions of disease and health. Are some cases of non-union of bones generally to be explained by a deficiency of this enzyme? Bricks and mortar may be present, but the workman may be absent. Numerous studies in blood chemistry in cases of non-union of bone indicate that the absence of union is not due to lack of calcium and phosphorus in the blood. It is well known that in such conditions as osteogenesis imperfecta and osteomalacia, while there is a great lack of lime salts in the bones, the multiple and successive fractures which occur usually heal readily.

There are no soft tissues about the neck of the femur in which preosseous material can form; and the periosteum is not a prominent structure as on the shafts of long bones, if we grant that periosteum and osteoblasts have anything to do with bone formation; and the blood-supply to the head and neck of the femur comes through the bone itself and not from surrounding soft tissues.

Whether or not the presence of synovial fluid about the fracture has anything to do with union or non-union we do not yet know. Some observers think the head may receive a slight amount of nourishment from the fluid, others think the fluid may be detrimental to the formation of callus.

However, since callus can be formed alone from the distal fragment, where alone there is life, any slight motion of the fragments after reduction will break up the callus very easily.

It is, therefore, very obvious that the question of union or non-union of a fracture of the femoral neck is a complicated one and some of the factors are still obscure. In estimating the worth of any method of treatment we

must rely on imperfect statistics and on our conception of how effectively the method meets the conditions mentioned above.

But it will be evident from this study that some fractures do not unite by any method of treatment. Certain ones seem doomed to failure of union from the moment of the accident, either because of serious injury to the blood-supply or because of some more obscure reason for defective osteogenesis. May it be possible to recognize this type of case early in its history in order to avoid prolonged but hopeless treatment?

In addition to these particular cases of non-union we will be confronted with a far larger number in which the failure of union has been due to unsuitable or improper treatment of the fresh fracture. What shall we do for these patients? Shall we let them alone or operate on them? If we operate, how shall we decide whether to attempt to secure union by a bone graft, or by the Brackett operation, or by fixation with some foreign body; or, on the other hand, to give up all thought of union and do a Lorenz bifurcation operation, or remove the head alone as advised by Sir Robert Jones, or combine this procedure with a reconstruction operation as devised by Whitman or Albee?

If we try for union, we will have a certain percentage of failures in securing good anatomical and functional results. A reconstruction operation is then imperative.

But if we go one step farther in our inquiry and ask what are the results of a reconstruction operation, we shall discover that here, too, we have failed to cure all of our patients. We have not given to all a stable, painless, and freely movable hip. We have failed to restore some of these long-enduring and long-suffering souls to a useful and happy life. We have cured not even their pain. And here the literature leaves us. We have reached the end.

The whole picture seems to be rather gloomy and dismal. First of all, there is a high mortality in fractures of the neck of the femur. Under the best non-operative methods of treatment we may expect bony union in not more than 50 to 60 per cent. and in a much smaller percentage than that in patients over sixty years of age. We treat the patient by taking him off his feet for from six months to a year and then we discover that he cannot use his hip. He consents to a bone-peg operation and lies in a plaster cast for three months and then uses crutches and a brace for another six months or more and is unable to throw them away. He eventually returns to the hospital a third time and we make him a new joint. At the end of another six months he may be walking and he thinks that at last the surgeon has cured him. But after the years have passed, be they few or many, his old enemy, pain, grips him again by the hip. He has developed an osteo-arthritis in his false, and I might say hollow, joint. It is a hollow joint—the femur has not stayed in the socket.

Non-Operative Treatment.—But I draw too sad a picture. Surgery has accomplished much in recent years. Sir Astley Paston Cooper believed that fractures of the olecranon, the patella, and the neck of the femur do not unite

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by bone. Oscar Allis, in comparatively recent times, stated that we cannot hope for bony union in fractures of the femoral neck.

A British fracture commission about twenty years ago stated that only 22 per cent. of cases treated by the older conventional methods secured a good result judged even by weight-bearing standards, and that in thirty-six cases over sixty years of age only five had a good result (13.8 per cent.). Sir Robert Jones states that Katzenstein, in a report made to the Surgical Society of Berlin, in 1928, asserted that in 119 cases of transcervical fracture only 11.5 per cent. secured good results by conventional methods of treatment.

Walker, in 1914, reported results obtained in the treatment of 112 cases in the Bellevue Hospital in New York during the years 1906 and 1907, and stated that in only 13 per cent. were good results obtained.

These figures may be considered as fairly representative of the conventional methods of treating fractures of the neck of the femur before the Whitman abduction method became generally recognized and acknowledged to be a distinct advance in the handling of this fracture. The acceptance of the Whitman method marks a new epoch in the heretofore dreary history of this condition. The statistics thereafter begin to show a decided improvement. The author has carefully reviewed all articles published in the English language during the past fifteen to twenty years, and from these selects the following statistics as being fairly representative:

Dorrance, in 1918, reported eleven cases treated by the Whitman method with but one failure. In 1920, the same author, in conjunction with Murphy, reported twenty cases with good results in 45 per cent., fair results in 15 per cent. and bad results in 25 per cent.

Powers, in 1922, reported twenty-two cases with 93 per cent. good results. Campbell, in 1919, and again in 1923, reported series of cases with 90 per cent. good results. Ashhurst and Crossan, in 1926, reported 43 per cent. good and 37 per cent. fair results. Löfberg and Waldenström have obtained bony union in 80 per cent. of a large series of cases. Higgs, in the 1927 Proceedings of the Royal Society of Medicine, reported five cases treated by the Whitman method with good results in all, and six cases treated by extension with 100 per cent. failure in securing union.

On the other hand, Janecke, in 1922, in the *Beitr. z. klin. Chir.*, reported 123 cases treated by extension, of whom 66 per cent. had a usable hip. Hey-Groves, in 1930, reported 42 per cent. good and 22 per cent. fair and 26 per cent. poor results in 116 cases.

Reggio, in the October, 1930, issue of the *Journal of Bone and Joint Surgery*, published a very careful study, one of the most painstaking and complete to be found in the literature, of end-results of all cases treated in the fracture service of the Massachusetts General Hospital during the years 1921 to 1927. Forty-nine cases were treated by the Whitman method and twenty-one by other methods. Omitting the dead and the cases in which results were unknown, the Whitman method gave 60 per cent. good, 16.6 per cent. fair and 23.4 per cent. bad results. Union occurred in 80 per cent. In treatment by other methods, good results were obtained in 36.4 per cent., fair in 18.3 per cent. and bad in 45.4 per cent. Union was obtained in only 45.4 per cent. The mortality was practically alike in both series of cases, about 25 per cent. for the entire group and about 30 per cent. if unknown cases are omitted.

Reports of the fracture commission of the American Orthopaedic Association made in 1929 and 1930 contain the following: In a study of 201 cases over sixty years of age the percentage of proved bony union was 30.4 per cent., and the percentage of entirely

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satisfactory results was 50.4 per cent. A second series of 365 cases under sixty years of age showed 51.9 per cent. proved bony union and satisfactory end-results in 57.7 per cent. Practically all had been treated by the Whitman method.

Other methods of treatment, such as the Maxwell-Ruth method, have their present-day advocates, but we have no statistics whereby we may fairly judge of the end-results secured by them, and we must hold them for the present *sub judice*.

Making due allowance for the faults of statistical tables, and granting that some surgeons because of their greater expertness in manipulation and in putting on plaster cases may get better results than others, it is still evident that the use of the Whitman method has given vastly better results than the older methods of treatment and that good end-results may be expected on a general average in 50 per cent. to 65 per cent. of cases.

We must remember, however, that the age of the patient has a tremendous bearing on the mortality and on the result that may be obtained by any method of treatment.

Wilson, in his series, had no deaths in patients under fifty years. Between fifty and sixty years, the mortality was 18 per cent. in sixteen cases; between sixty and seventy years, 28 per cent. in thirty-two cases; between seventy and eighty years, 54 per cent. in twenty-four cases; over eighty years, 100 per cent. in eight cases; 40 per cent. in all cases. Bony union occurred in 80 per cent. under fifty years, between fifty and sixty years, 18 per cent.; between sixty and seventy years, 38 per cent.; and not one of seven surviving patients between seventy and eighty years got bony union.

Dorrance stated that we should not expect bony union in patients over sixty-five years of age.

Reggio's figures under Whitman treatment (omitting dead and unknown) are as follows:

Age—Years	No. Cases	Mortality	Good Results
Under 50	9	0.0 per cent	87.5 per cent
50-60	13	15.0 per cent	62.5 per cent
60-70	7	30.0 per cent	60. per cent
70-80	18	44.0 per cent	37.5 per cent
80-83	2	50.0 per cent	0.0 per cent

The total mortality figures vary greatly from 6 per cent. to as high as 41 per cent. Stebbins (*Brit. Jour. Surg.*, 1927) cites 111 cases with forty-six deaths, thirty-one of which occurred without leaving the hospital, seven within thirty days after leaving, and eight lived six months and two for over a year. Wilson's rate is 40 per cent. mortality. Löfberg gives 6 per cent. These discrepancies can probably be accounted for by the fact that some patients are too ill to undergo treatment and die without treatment. These have probably been excluded from certain statistics giving results of treatment. Reggio's total mortality was 26 per cent. A fair average of all cases may be assumed to be possibly 20 per cent. to 25 per cent.

Open Reduction and Internal Fixation of Fresh Fractures.—In recent years, there has been a growing inclination among a few surgeons to operate on selected cases of fresh fractures of the neck of the femur; and in one clinic, the fracture service of the Massachusetts General Hospital, Doctor Smith-Petersen has been doing an open reduction and driving in his special nail to secure accurate and effective internal fixation in a group of older cases. Other surgeons have used bone-pegs, plates and nails.

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The advantages claimed for the operative procedure are that accurate apposition is obtained, certainly conducive to early and good union, and that the time spent in bed and in the hospital is greatly shortened. These patients are able to bear weight early and their period of disability is greatly shortened. These advantages, if true, are not lightly to be considered. The shortening of the period of disability among wage earners under sixty years of age is of vast importance. If, in addition, it gives a greater percentage of bony union than do non-operative methods, it should be the method of choice by capable surgeons unless the dangers of the operation outweigh its manifest advantages.

Unfortunately, no published statistics have been found. I have received the following personal communication from Smith-Petersen:

<i>Age of Patients:</i>		<i>Duration of Fractures:</i>	
20 to 30 years.....	2	1	10 months non-union
30 to 40 years.....	2	1	15 months non-union
40 to 50 years.....	2	1	19 months non-union
50 to 60 years.....	9	1	2½ years non-union
60 to 70 years.....	7		
70 to 80 years.....	1		
80 to 90 years.....	1		

In three of these non-union cases bony union was obtained. The fourth case, that of two and a half years' duration, had an excellent functional result when last seen, five and a half months after operation, but the bony union was questionable. She is one of the cases classified in the end-result table as having no end-result. The fact that bony union has been achieved in so many of these cases of non-union of long duration speaks well for the method.

In four of the twenty-four cases treated no end-result has been recorded since it was impossible to get in touch with the patients. The end-results of the remaining twenty cases are as follows: Bony union, 15, 75 per cent. Non-union, 3, 15 per cent. Deaths, 2, 10 per cent.

Nine of his twenty-four cases of recent fracture were over sixty years of age and nine more were between fifty and sixty years. Six were under fifty. His figures do not allow us to analyze the results according to the age of the patient. His mortality is no higher than might be expected from any form of treatment. In fact, it is much lower than the general average, but his group of cases was doubtless selected. Bad surgical risks were probably not operated on. It is reported that his patients have little or no shock and pain. This is entirely credible.

The author's experience in eighteen operations for ununited fractures of the neck of the femur and in more than two hundred other operations on the hip-joint for various conditions has been that surgical shock is practically negligible and that there has been but one death, and that one because of a re-kindled infection in a case of old osteomyelitis.

The use of an autogenous bone-peg for internal fixation necessitates a second operative procedure and probably adds to the risk. No statistics are available for its use in fresh fractures.

Certainly open operation gives us far better facility to control the movement of the head, to remove interposing soft tissue and to secure accurate apposition and impaction of the fragments than does any closed method of treatment. It seems probable that it will never come into general use for the treatment of all fractures of the femoral neck, but that capable surgeons accustomed to operating upon the hip will employ it more frequently in cases that are good surgical risks.

Treatment of Ununited Fractures.—In considering the treatment of non-union one must first decide whether to let the patient alone or to operate on him. Many cases, particularly among the aged, are not suitable cases for any operation. Henderson, of The Mayo Clinic, reports one series of 120 cases of which only twenty-six were operated on. Of these twenty-six, only ten resulted in bony union and good function, 8.3 per cent. of the total number of cases. Generally speaking, most patients under sixty years of age may be offered hope of improvement by some type of operation and many patients beyond this age period may fall in the same category. But each case must be decided on its own merits. Some patients may not seem to be good operative risks, but operation is more or less imperative to relieve them of pain which is slowly but surely killing them. They prefer any risk to their present condition of pain and helplessness.

The surgeon must next decide whether to attempt to secure union or whether, by a reconstruction operation, to sacrifice the head of the femur and hope to obtain a painless, movable and stable hip.

If he decides upon the former procedure, he is offered a choice of methods of operation. But it is essential in all of them that he should remove all soft tissue from the fractured surfaces of the two fragments and from between them, that he should freshen these surfaces, place the fragments in close contact with proper alignment and maintain their accurate position by internal or external fixation or by both, until union has occurred.

If the distal surface of the head of the femur is concave and flush with the rim of the acetabulum, as the author has observed it to be at times, and if the neck is completely absorbed and the shaft is also concave in shape where the neck had been present, it is impossible to secure contact of the two fragments except by using the Brackett operation.

If the proximal fragment is not viable, union should not be expected. Possibly, at times, union may occur after operation even when the head is a piece of dead bone. Vessels may grow from the freshened surface of the distal fragment into the dead bone or grow along an autogenous bone-graft and rejuvenate the head or a portion of it. But it is very questionable whether this process can be complete. This theory may account for those cases which appear to get bony union but which a year or two later show a collapse of the head. Santos and Phemister suppose that weight-bearing

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was allowed too early. I am inclined to believe such collapse would occur anyway because of incomplete reestablishment of circulation in the head, and defective regeneration of its bony structure.

Some cases of recent fracture which are well treated, have had good reduction and firm fixation, fail to unite. More or less rapid absorption of the neck occurs. Is it because the blood-supply has been so seriously injured at the time of the accident or by subsequent thrombosis that it cannot be reestablished, or is there some more obscure reason for the complete breakdown of osteogenesis? However, whatever the cause may be, it does not seem reasonable to suppose that we can do by operation what nature has failed to do under the best possible conditions.

Therefore, the author believes it to be unsafe to attempt to secure union in those cases which have shown rapid or complete absorption of the neck, in those in which the X-ray gives evidence of the death of the proximal fragment, and in those which, at the time of operation, present gross evidence of the death and degeneration of the head. Some proximal fragments are dry like the pith of an elderberry branch; some have only a thin, fragile cortex of bone, while the interior consists of a soft, degenerated tissue which can be scooped out with the finger. In many the articular cartilage of the head has largely disappeared. None of them bleed when dug up with a gouge.

In 1925, Albee stated that 90 per cent. of old fractures require a reconstruction operation and but 10 per cent. are suitable for a bone-peg operation. In 1928, he revised that statement in the light of his end-results and asserted that a greater per cent. are suitable for the bone-peg operation. In 1929, he reported end-results in 228 cases with an excellent result in 90 per cent. of the bone-graft operations and in 75 per cent. of the reconstruction operations.

Henderson states that the bone-peg operation should not be done on patients over fifty-five years of age, or in others who have had a marked absorption of the femoral neck.

Ellis Jones states that he secured good functional results in 90 per cent. of his bone-peg operations in twenty-one cases and good results in seventeen cases of Whitman reconstruction operation. But in the aged a reconstruction operation is inevitably followed by osteo-arthritic changes which make the hip increasingly painful. He believes that the Robert Jones operation of excision of the head through a posterior incision, followed by a long period of freedom from weight-bearing with a caliper splint gives as good results as any reconstruction operation. The bone-peg operation when successful gives the best functional results. He believes the radiograph is not a sure criterion in judging the viability of the head.

The author's experience with the Whitman reconstruction operation has not been happy. He has found that the end of the femur does not remain in the acetabulum. According to the simple law of mechanics whereby a force directed obliquely against a hard surface is divided into two components, the thrust of the straight femur against the oblique acetabulum must expend itself partly in a direction at a right angle to the plane of the acetabulum and partly in a direction parallel with the plane of the acetabulum. The

latter tends to force the femur out of the acetabulum. Furthermore, any degree of adduction of the femur by increasing the angle of incidence increases the outward thrust. In the normal femur the angulation of the neck with the shaft lessens the angle of incidence and maintains the head more securely in the acetabulum.

As the femur slips upward after a reconstruction operation it rests against the upper rim of the acetabulum. This margin may enlarge to meet the increased demand upon it or it may break down completely. The latter is more apt to occur in the older patients. The acetabulum gradually becomes obliterated and the weight of the body is borne largely by the sloping side of the pelvis and the soft tissues. Osteo-arthritic changes become apparent in many cases. Mechanically, these cases strongly resemble old cases of congenital dislocation of the hip. It is well known that unilateral cases of dislocation may lead practically a normal life for many years without pain. Eventually, however, as they get older some of them at least become incapacitated by pain.

Mechanically, therefore, a reconstructed hip does not appear to be adapted to long-continued and normal function. Youth may adapt itself to the altered conditions of weight-bearing, but age is slow to change, and changes, when they occur, are apt to be retrogressive.

Albee (*Jour. Bone and Joint Surg.*, October, 1928) cites thirteen cases of reconstruction with excellent results. Eight of these were under fifty years of age, three were in the fifties, and two in the sixties. The cuts illustrating the paper show end-results in two cases, one sixty-seven years of age and the other forty-four years of age. Both illustrations emphasize the points I have just made. In the former, the femur stands out beyond the pelvis and only the inferior part of the base of the neck appears to be in contact with the upper rim of the socket; and in the latter, the acetabulum is obliterated, the upper margin of the acetabulum is hypertrophied, and the great trochanter seems to have worn a false acetabulum on the side of the pelvis.

The author may appear rash in criticizing the reconstruction operation, but mechanically it does not appear sound and clinically it has not given good results in his hands.

The Lorenz bifurcation operation has been used somewhat in Europe with favorable outcome. The author has had no experience with it and has not found any definite statistical reports on the end-results obtained by it. Sir Robert Jones has recently given his approval to this procedure in proper cases.

And here, as far as the literature is concerned, we have reached the end of our possibilities in the treatment of fractures of the neck of the femur.

Certainly there is a residuum of cases in which all methods of treatment have failed in restoring the function of weight-bearing and in relieving pain. Is there nothing further to be done? Must we accept defeat?

Arthrodesis of the Hip.—Four years ago the author began to employ arthrodesis of the hip in selected cases as a solution to this problem. At first he used it as a last resort when a reconstruction operation had failed. A

FRACTURES OF THE NECK OF FEMUR

little later he performed an arthrodesis in preference to a reconstruction operation. And still later, he has employed it in two cases of fracture but three months old which in that brief time had undergone practically complete absorption of the femoral neck.

It is apparent that a hip ankylosed in good weight-bearing position is far superior to a painful or unstable hip in which motion is present. A patient with a fused hip can engage in all his normal activities of life and do practically everything but lace his own shoe. And, indeed, some learn to do this.

If, therefore, we could secure a firm arthrodesis after all other methods have failed in relieving the patient of pain and disability, we might all agree without argument that the problem had at last been solved, provided the patient survives the many months and even years consumed in the treatment of the fresh fracture, and the subsequent ununited fracture. The shock of operations, the wearing pain he has endured, and his prolonged inactivity have not tended to lengthen his life.

This leads us to inquire whether, if there are some cases doomed to failure of union from the moment of fracture, we might not find some means of recognizing them early in their history and resort at once to an operation which gives promise of their early return to a life of happiness and usefulness.

If, after three or four months of conservative treatment of the fresh fracture, either by a well-executed Whitman abduction manipulation or by open operation with reduction and internal fixation, it is apparent that union is not taking place but that progressive absorption of the neck is occurring, it seems reasonable that we should seriously consider an early arthrodesis of the hip.

What are the difficulties and limitations of arthrodesis of the hip?

The hip-joint, very perversely, frequently becomes ankylosed when we desire to preserve or restore motion, and on the other hand persists in maintaining mobility when we desire ankylosis. Not all operations of arthrodesis are successful in securing bony fusion. Possibly this may be the result of our technic. We may improve our results with more experience. We may also at length discover the reasons why, with the same technic of operation in two cases, one results in success and the other in failure. We cannot avoid the conclusion that the fault may be much more deep-seated than mere method of operation. In some cases, there appears to be an utter lack of callus and new bone formation even when the conditions created by the operation seem to be most favorable for union of the two bones. This is particularly apparent in the case illustrated in Fig. VII. The great trochanter with the outer portion of the shaft of the femur was removed and turned around. The lower end of this transplant was buried in a notch in the pelvis above the acetabulum while the upper end of the transplant was placed again in contact with the shaft of the femur. This graft has united again with the femur but not with the pelvis, and the end of the femur has not fused with the pelvis although both bones had fresh bleeding surfaces when placed in contact at the time of operation.

On the other hand, in Fig. II and Fig. V we see a perfect fusion of femur and pelvis under the same conditions and without the aid of a graft. In Fig. VI we see failure where in the last two cases there was success. There must be some conditions lacking for osteogenesis in these cases which we do not understand. It is not the age of the patient. We have succeeded in a man of sixty-five where we have failed in a man of thirty-nine. If we eventually discover these conditions we may learn why some fractures of the hip do not unite in the first place.

Is there any upward age limit at which we may not hope to secure an arthrodesis of the hip? A larger experience only can answer this question. The one case mentioned above was sixty-five years old at the time of his operation.

Is the operation limited in its application because of its severity? It may be said that the author has seen no instance of shock following it. There has been no mortality. The patients do not suffer any undue amount of pain. Case II was a poor operative risk. The medical men said he had three chances out of ten of coming through the operation alive, because of a damaged heart. But he passed through the operation and the convalescence with no untoward symptoms. He is living today because of the operation, not in spite of it. Relief from constant pain and worry and inactivity has probably lengthened his life. The author always digitalizes his patients by hypodermatic injections of digalen over a period of forty-eight hours preceding any major operation.

The objection may be made that since we fail to secure an arthrodesis in some of our cases we still have a minimal residuum of patients who are not cured, and that we are, therefore, no farther advanced in the ultimate solution of the problem than we were before; that it is like an approach toward the infinite—we are always progressing but never reach the end. Answer may be made that we do succeed in our efforts in a fair proportion of cases and that even in our failures we leave them with a much more stable hip than they could possibly have by any reconstruction operation. Case IV failed to get an arthrodesis, yet for three years he has had a painless hip and has worked as a mail-carrier, walking twelve to fourteen miles a day in the discharge of his duties.

This last case makes us inquire whether we might not deepen the upper portion of the acetabulum or reinforce its upper margin and use some method to preserve motion instead of seeking ankylosis.

It is evident from this entire discussion that the last word has not yet been spoken concerning the treatment of fractures of the neck of the femur. Much progress has been made since Whitman announced his revolutionary method of treatment thirty-four years ago, and it is only by our continued interest, our careful observation and research that we may hope to make further advances in treating this surgical condition which has such a high mortality and which strews our professional pathways with so many wrecks.

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SUMMARY

(1) Some patients on admission to the hospital are not fit subjects for any treatment directed toward the reduction and fixation of the fracture.

(2) There is a high mortality, probably 25 per cent., when all cases of fracture are included in the statistical tables. The mortality rate increases rapidly beyond the sixtieth year of age.

(3) Non-operative methods of treatment of recent fractures will continue to be used in the majority of cases. Of these the Whitman abduction method has given the best results.

(4) Open operation should be the method of choice in selected cases.

(5) The most common causes of non-union are failure in making a diagnosis of fracture, and improper treatment of cases which have been correctly diagnosed.

But non-union may be expected in 20 to 25 per cent. of cases treated by the Whitman method or by open operation. The rate is low in patients under sixty years and increases rapidly beyond this age.

(6) In ununited fracture, if the head is viable and if a fair portion of the neck has survived, union may be hoped for in 75 per cent. to 90 per cent. by means of an autogenous bone-graft or a Smith-Petersen nail.

(7) Satisfactory union should not be expected in the presence of necrosis of the head, rapid and complete absorption of the neck and in the second class of cases mentioned in item 5, where nature has already failed in osteogenesis under the most favorable conditions that tend to union anywhere and any time.

For this group of cases a reconstruction operation offers a 75 per cent. chance of securing good function in patients under sixty years of age. In patients beyond this age its advantages are very doubtful.

(8) Arthrodesis of the hip affords relief to some patients after any or all of the above-mentioned operations have failed.

If it becomes possible to select early in their history those cases that are doomed to failure of union by any method of treatment, an early arthrodesis will avoid months and years of useless treatment and disability.

CASE REPORTS

CASE I.—J. D., fifty-two years old. Fracture neck of right femur October, 1924. Treated for several weeks in hospital without extension, sand-bags or any other method of fixation. Discharged without being told he had a fracture. Unable to walk since injury except with crutches. Constant pain.

April 29, 1925.—Whitman reconstruction of right hip. Complete absorption of the neck. Head was flush with the margin of the acetabulum. Fractured surface flat and smooth. Concavity present on the side of the femur where the neck should have been. Joint capsule filled with thick, straw-colored fluid containing several loose bodies. Great deal of proliferated and degenerated material apparently coming from synovium. No bleeding from head on being dug with gouge. Bone soft. Gave appearance of fatty degeneration. Bone could be broken easily.

September 21, 1925.—Discharged from hospital. Able to walk well without pain.

October 17, 1931.—Has no pain. Walks with cane, but can walk without. Can lace

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his own shoe. Two inches shortening. Walks with external rotation. Cannot be internally rotated beyond mid-position. Fifteen degrees abduction, five degrees adduction present. Flexes thirty degrees beyond right angle. No pain on motion. Patient states that he feels grating in his hip on weight-bearing. Femur can be felt to move up and down slightly on the side of the pelvis. Wears one-inch elevation.

CASE II.—T. G., sixty-three years old. Was thrown from moving train September, 1926. Treated immediately in a Philadelphia hospital with sand-bags, without traction and without abduction. He was discharged in two months as cured.

December 5, 1927.—Has been confined to house since discharge from hospital. Able to move his leg but not to bear weight on it. All motion restricted except internal rotation. One and a half inches shortening. Non-union of neck of femur.

December 7, 1927.—Whitman reconstruction operation.

January 17, 1928.—Case removed. Slight motion without pain.

January 31, 1928.—X-ray examination shows femur riding on edge of acetabulum. Another case applied with thigh in abduction.

March 15, 1928.—No pain. Using crutches. Can bear weight without difficulty. Discharged from hospital.

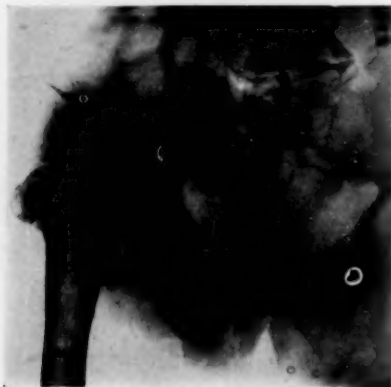


FIG. 1.



FIG. 2.

FIG. 1.—(Case I.) Fifty-two years of age at time of operation. The only case with satisfactory function after Whitman reconstruction, six years after operation.

FIG. 2.—(Case II.) Sixty-five years of age at time of operation. Two years after arthrodesis.

April 10, 1928.—Constant pain. Femur out of socket.

May 8, 1928.—X-ray shows osteo-arthritic changes and new bone formation. Ninety degrees motion. Rotation fair. No abduction.

November 4, 1929.—Re-admitted to hospital because of constant pain day and night. Unable to bear weight. Statement made by medical men because of bad heart: "He has three chances out of ten of surviving operation on his hip." Patient stated that he preferred to be dead rather than to continue to suffer present pain.

December 11, 1929.—Arthrodesis of hip.

March 26, 1930.—Case removed. X-ray shows union.

April 20, 1930.—Discharged from hospital.

November 2, 1931.—Gets about without use of crutches. Leads practically a normal life. No pain. Solid union in good position. Able to walk a mile. Goes about on trolley cars.

CASE III.—F. C., fifty-one years old. Fracture neck of femur, January, 1929. After admission to hospital fragments were in perfect position. Treated with Buck's extension and sand-bags. Rapid absorption of neck of femur so that at the end of three months neck had almost completely disappeared with displacement of the shaft.

March 26, 1929.—Arthrodesis of hip. November 2, 1931.—Arthrodesis solid. Does

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FIG. 3.—(Case III.) Fifty-one years of age at time of operation. On admission to the hospital.



FIG. 4.—(Case III.) Three months after admission to the hospital. Complete absorption of the neck.



FIG. 5.—(Case III.) Two years and seven months after arthrodesis.

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her housework. Takes care of her mother who is seventy-two years of age. Kneels and scrubs floors. Does all her own shopping. No pain except occasionally in rainy weather. This pain is felt in the adductor region.

CASE IV.—C. W., thirty-eight years old. Had fracture of neck of right femur June, 1928. Treated in hospital but fracture was not recognized, and was told that he had a sprain of his hip. Had pain and was unable to bear weight. X-ray made at the Orthopaedic Hospital in September revealed ununited fracture.

October 26, 1928.—Brackett operation. Neck was largely absorbed. What was left of the base of the neck was crater-like, with portion of cortex remaining about one-half inch long. Medulla had undergone degeneration and absorption. Head of the femur was flush with the acetabulum. It bled on being denuded. Great trochanter was removed. Upper end of femur was rounded off and reduced in size. It came in firm contact with the head when the leg was abducted. Greater tuberosity was fastened to the shaft lower down. Leg dressed in abduction and slight internal rotation.

October 10, 1929.—Operation unsuccessful. Failed to get union. Fibrous union present which allowed weight-bearing fairly well but with considerable pain.

October 10, 1929.—Arthrodesis of hip. October 17, 1931.—Failure of union. Fifteen degrees motion. Leg in good position. One and one-fourth inches shortening. Has



FIG. 6.

FIG. 6.—(Case IV.) Thirty-nine years of age at time of operation. Two years after arthrodesis. Failure of fusion.



FIG. 7.

FIG. 7.—(Case V.) Forty-nine years of age at time of operation. Six months after arthrodesis. Failure of fusion.

been working for one and a half years as mail-carrier, walking twelve to fourteen miles a day. On returning to work after two weeks' vacation this summer he began to have moderate pain in his hip after walking six to eight miles.

CASE V.—K. S., forty-nine years old. Fracture of neck of femur April 17, 1930. Has suffered constant pain, even at night. Unable to walk. April 23, 1931.—Arthrodesis of hip, intra- and extracapsular.

October 15, 1931.—One inch shortening. Good position. Slight abduction and slight flexion. Ten degrees motion present in flexion; no rotation; no abduction; no adduction. X-ray shows non-union.

CASE VI.—L. W., fifty-nine years old. Fracture neck of femur December, 1919. Treated in various ways, including Buck's extension. March 1, 1923.—Non-union. Complete absorption of neck. Has pain at all times. March 20, 1923.—Reconstruction operation.

September 23, 1923.—Discharged from hospital. Fair result. Has some pain on motion. October 24, 1931.—Marked disability. Can walk very little with the use of one or two crutches, or leaning on some one. She can get about in her room without a crutch by holding to different objects. Has pain. Poor result.

KNEE-JOINT ARTHROTOMY*

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IN NOVEMBER, 1925, the writer read before the New York Surgical Society, a paper entitled "Arthrotomy for Knee-Joint Calculi."¹ At that time, forty-nine cases of arthrotomy were reported, a group operated upon in the interval between February 9, 1919, and November 9, 1925. In the present essay have been collated 137 additional cases operated upon since then, making a series total of 186 up to January, 1932.

From a clinical standpoint this review assembles itself into three groups as to *causation*, namely, (1) traumatic; (2) infective or metastatic; and (3) a mixed group in which trauma and infection are inter-related. *Trauma* damages the cartilages, the fat pads, the synovia, the ligaments, and, less often, the bony elements. *Infection* damages and distorts the same structures and registers especially on the synovia and the bony elements. As to *duration*, we recognize three groups, namely, (1) acute or primary; (2) subacute or intermediate; and (3) chronic or late. As to *anatomical site*, we find the chief zone of knee-joint dysfunction to be the internal meniscus; next, hypertrophic synovitis; next, hypertrophied subpatella fat pads, and thereafter a scattering represented by exostoses (hypertrophic osteoarthritis), osteochondritis desiccans (five cases) and cysts (three cases). In practically every instance there is an association of pathological findings so that, for example, in a knee locked for eight days by a "bucket-handle" type of internal meniscus there was already a complicating hypertrophic synovitis.

In the former presentation we stressed the analogy between intra-abdominal and intra-articular knee lesions and referred to arthroliths, or "joint mice," as calculi to signify the relationship pertaining between knees and fecaliths in the appendix and calculi in the gall-bladder and urinary tract. We are impressed anew with this relationship by later experience and again state that there is such a thing as knee-joint indigestion and knee-joint colic, both of which, as in the abdomen, are curable by surgery rather than by drugs, diet, physiotherapy or apparatus.

The wide exposure of the knee-joint later to be recommended has been called by the French "laparotomy of the knee-joint," and this appellation serves to again remind us of the inherent similarity between the abdomen and the knee. There is assuredly a "surgical knee" with as great certainty as there is a "surgical abdomen," and the cure for one is genuotomy and for the other laparotomy. Further, the analogy is the more striking when we recall that today laparotomy is in every respect truly exploratory and the

* Read before the N. Y. Surgical Society, January 27, 1932.

¹ ANNALS OF SURGERY, March, 1926, LXXXIII, p. 392.

small incision is limited strictly to the acute group in which the lesion is sharply defined, as, for example, in appendicitis with classical signs and adequate findings. No longer does the small incision suffice in laparotomy for subacute or chronic cases, and the prudent surgeon explores not only the suspected region but also is alert as to the possibility of additional or complicating lesions in viscera more or less adjacent. Exactly the same experience befalls the arthrotomist, so that now the exposure is in all respects a real exploratory making every recess of the joint available.

Since October, 1923, we have abandoned every approach to the knee except the medio-lateral incision, to be described later. In the first series of cases reported we used the patella-split incision (Ollier or Jones approach) in twenty-three of the forty-nine cases, the lateral or small incision in twelve, and the medio-lateral incision in fourteen. In this additional series of 137 cases the medio-lateral incision was used 132 times.

Causation and Symptoms.—As stated, we recognize *trauma* as the determining factor in the acute and recurrent group, and here indirect violence is the usual source, although in a few of our cases direct trauma was the only element in the history. The usual story is that the knee was twisted, rotated or abducted, and thereafter pain, swelling and dysfunction appeared. This trinity of symptoms is relatively constant, and if added thereto we find local tenderness, crepitus and atrophy, the diagnosis is almost pathognomonic from the history and these six findings alone. Auscultation by the ear or stethoscope often elicits a single loud suggestive click. X-ray examination is corroborative only if calcified deposits, bone and foggy synovia become visualized. Air injections preliminary to X-ray examination we abandoned some years ago because the findings were inconstant and inconclusive. We have not used the arthroscope. Locking of the joint is a rather rare sequel in our series; but, as indicated, dysfunction is important in respect to limitation of full extension. It is a strikingly frequent complaint that dysfunction is manifest on ascending or descending stairs, and nearly all the patients volunteered the information that the joint had to be favored or guarded and was not to be relied upon for weight-bearing unless in full extension. We have been surprised at the early onset of atrophy in the acute group, and even after ten days it may be quite noticeable. We are convinced that the effusion in the traumatic group is always bloody, and that hence the term "water on the knee" is a misnomer.

We have aspirated liquid blood as late as eleven weeks after the onset of a synovitis associated with an internal derangement. In the subacute and chronic group, however, the joint effusion may resemble in color and structure normal synovial fluid.

In passing it is pertinent to say that the stability of the joint is directly related to the integrity of the quadriceps group of muscles and their associates. In point of fact, the capsule of the joint is the terminus of this muscle group and no knee-joint is stronger than the muscles controlling it. Hence the importance of muscular activation as a part of the treatment, and in

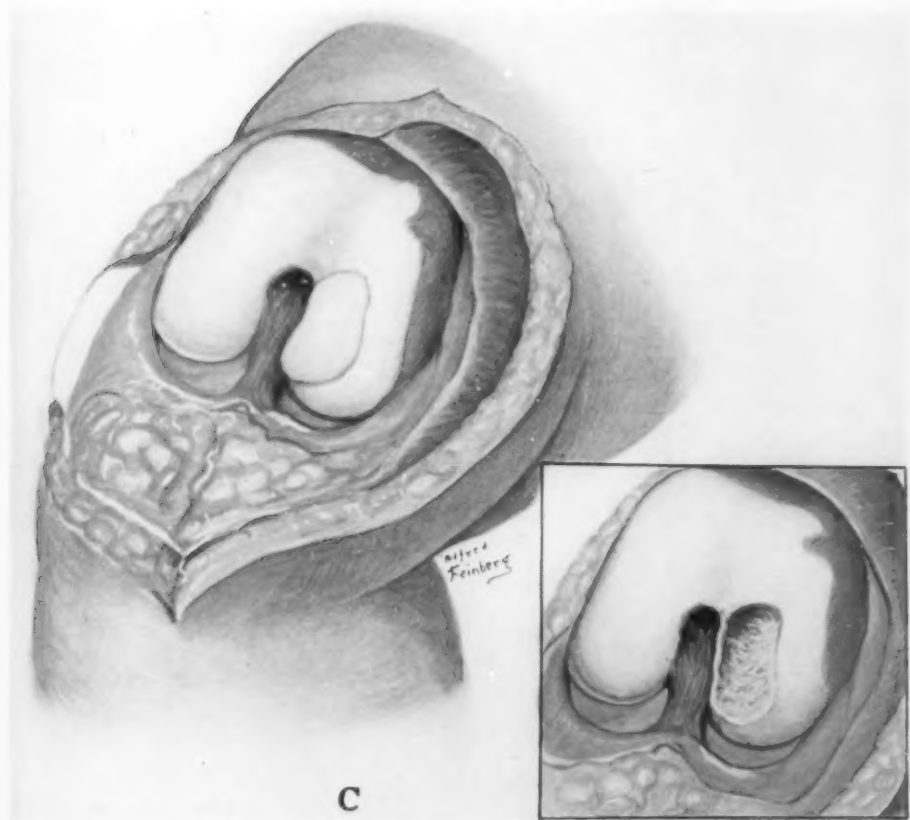
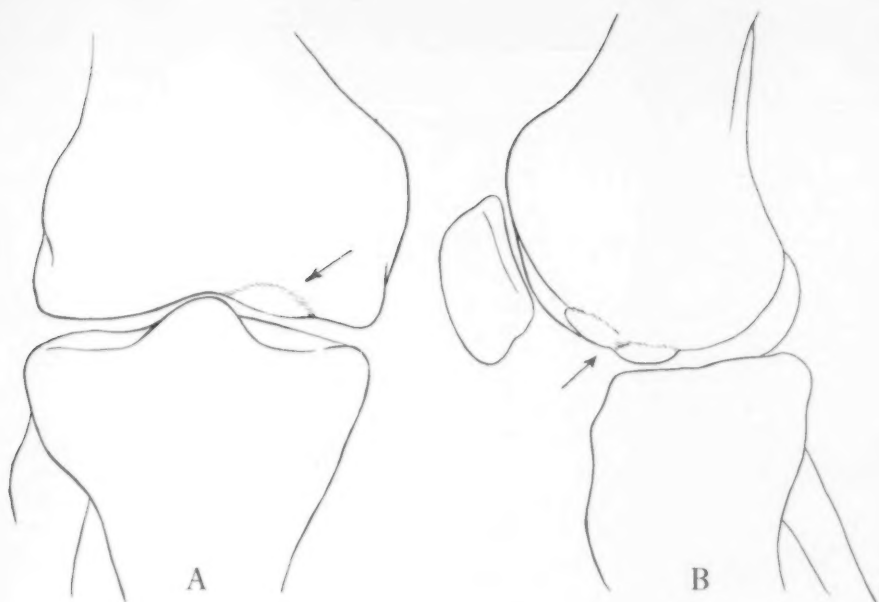


PLATE I.—Osteochondritis desiccans. A and B are X-ray tracings. C—The actual operative appearance.



KNEE-JOINT ARTHROTOMY

some of our cases we have deferred operation until muscle tone was restored by special exercises.

In the subacute and chronic group, the causative factors of arthritis are often added. We are convinced that an initial trauma may provide the necessary nidus or media for the onset of arthritis, monarticular or polyarticular. We have had a number of patients with the so-called "arthritic tendency" in various joints and have seen this register on the injured knee to such an extent that virtually a monarthritis was thereby created. It is our conviction that this combination of trauma and infection often induces within the joint that form of hypertrophic synovitis which becomes a self-perpetuator or renewer of infection. Again this recalls the analogy to abdominal surgery and we are thereby reminded that the pathological gall-bladder, with or without calculi, may be a focus for arthritis. In some of our cases of hypertrophic osteoarthritis, a trauma has apparently broken off a stalactite of bone or separated a calcified tab from hypertrophied synovia and thus created an active irritant in a zone relatively quiescent even though greatly distorted, as indicated clinically and by X-ray.

We have cultured the removed fluid in a large number of cases, but even after prolonged incubation we have rarely obtained a growth of pathogenic organisms.

In our analysis of the case we regard the history as the most important clue in determining whether we are dealing with a medical knee or a surgical knee. It is not necessary to have extreme violence in order to detach a meniscus or nip or pinch a subpatella fat pad or the villi of hypertrophic synovia. This last often is thick enough and fringed enough to resemble seaweed and the analogy is the more striking if within the joint there is a high tide created by excess of fluid. Often this synovia is patchy, gray or green, almost diphtheritic in appearance.

In such cases we remove the excess of synovia, performing a total synovectomy if indicated, and we have never felt that by so doing we have robbed the joint of an essential component. We are in accord with Key and others who assert that the lining of the joint is completely restored after operative removal. Likewise we excise excess tabs of subpatella fat, especially if knobbing or excrescences obtrude into the joint. Our experience is that restitution of the joint is promoted and not impeded by that form of surgery which aims to reconstruct the joint anatomically, and hence we have often removed a damaged meniscus, performed synovectomy, and chiseled and filed off bony knobs all at the same sitting. In two such cases we have done this on both knees, the patients being so much benefited by the repair of one knee that the same relief was demanded for the other knee.

This seems to be the best answer to the query as to the possibility of a stiff knee or added disability if the intrinsic elements of the joint are removed. We are again reminded by this experience that the same fear was once aroused in respect to appendectomy, cholecystectomy, nephrectomy and splenectomy.

Treatment.—For the initial or acute attack associated with hæmorrhagic synovitis, removal of the effusion by aspiration is desirable because function is more rapidly regained, capsular distension is prevented and the formation of loose bodies from fibrinous deposits will be less frequent. To aspirate properly it is helpful to visualize the front of the joint as the face of a clock, the figure XII at the top and the figure VI at the bottom. In the left knee the aspirating needle is introduced at III and passes to XII; in the right knee the needle passes from IX to XII. It is necessary to use a large-calibred needle because the effusion is often thick. Local anæsthesia makes the procedure almost painless. After the aspiration, a snug gauze and cotton dressing is applied and the patient is encouraged to walk and to perform certain exercises to activate the quadriceps. Of these may be mentioned shrugging the knee-cap, lifting the affected limb against resistance, and pushing against the foot board of the bed. We believe, as in an initial appendicitis, that operation is not indicated if the symptoms subside after a few days. However, if there is recurrence, if dysfunction persists, if there is local tenderness, then operation offers the best chance of cure. In passing it is pertinent to stress that form of local tenderness so prominent in the meniscus group. This sign is almost as pathognomonic as is appendicitis or cholecystitis and it is elicited by point pressure with the knee bent, and it can be accentuated by rotation of the tibia.

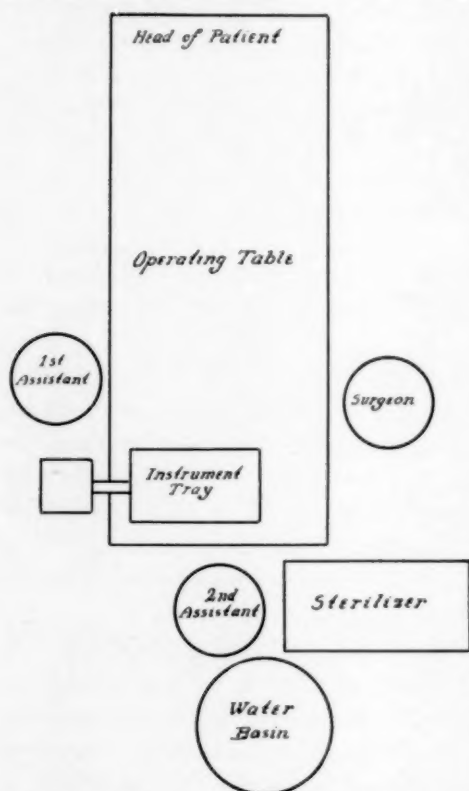


FIG. 1.—The set-up for the operating table (for the left knee).

Failure of non-operative treatment. (2) Definite evidences of cartilage injury, calculi or hypertrophic (villous) synovitis or hypertrophic osteoarthritis impairing joint function.

The Operative Approach.—As previously stated, we have abandoned the small incision directly over the meniscus even in acute cases because we have thereby missed associated pathology in two cases in which reoperation became necessary. It is surprising to find in almost every case of suspected semi-lunar injury, indisputable evidence of additional intra-articular mischief. This has created the suspicion that in some of our cases there already was distortion enough within the joint to make it the more responsive to the

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accused trauma. If this is so, then it is easier to understand why in some cases very slight violence is responsible for major effects, and very great violence produces only minor effects.

Operative Details.—(1) Overnight gauze dressing of iodine saline solution (Tr. Iodine one dram, saline solution one pint). (2) Spinal or inhalation anæsthesia. (3) Tourniquet on upper thigh. (4) Rigid ultra-aseptic or Lane technic. The suture nurse sets up her table and handles all instruments and drapes with clamps. The catgut sutures are wound around a special metal frame (nicknamed by us "The Lyre") and then are easily cut in the desirable eight-inch lengths. The "Dermal" skin sutures are threaded through a drainage tube and thus do not become snarled. (5) The assistants wear two pairs of gloves during the painting and draping of the field, and discard the outer pair when the set-up is complete. (6) A sterilizer is kept boiling at the end of the table, and each instrument, after once being used, is tossed into this and taken therefrom by the second assistant using clamps, and passed into a tray of cool, sterile water, and thence the instrument is returned to the instrument tray and handed therefrom to the operator or his first assistant by a clamp. (7) Specially shaped toweling is used to protect the skin edges.

The Medio-lateral Incision.—(1) Beginning at a point three or more inches above the top of the patella, the incision is carried downward in the median line to a point a finger's breadth above the top of the patella, and then around the inner (or outer) margin of same at the same distance to the mid-line, and thence downward to just above the tubercle of the tibia. (2) The above incision is carried down to the level of the deep fascia, and, by retraction, the fibres of the vastus internus are exposed to view. (3) The incision is then deepened along the same line, separating the muscular fibres, until the capsule is reached. (4) The capsule is then incised and the joint is exposed by carrying out the deeper part of the incision along the entire route already exposed. (5) The patella and the overlying parts are now retracted, either inward or outward, and the joint is flexed by bending the knee to almost a right angle by placing the foot against the opposite thigh. This exposes every compartment except the posterior. (6) Either meniscus is now exposed to view by use of the retractors, and, if damaged, is removed, beginning at the central portion. This removal is aided by grasping the inner margin of the meniscus with an artery clamp and further flexing the knee until the posterior part of the meniscus is exposed, and then it is removed as completely as possible. It is practically impossible to remove the entire meniscus by any sort of approach, but the remaining unremoved posterior portion is so small that it does not impede subsequent joint motion. (7) The joint is now placed in the extended position and, if necessary, synovial fringes or other pathological products are removed. (8) With the aid of a Reverdin needle, plain catgut No. 2 sutures are passed through the capsule at intervals of one-half inch. A similar closure is made for the deep fascia and the edge of the muscle. A few similar sutures are used for the superficial fascia. (9) The skin closure is made with "Dermal" suture material, also passed on a Reverdin needle. (10) No ligatures are used. (11) The sutured part is now covered by several layers of gauze moistened in the "I. S." solution already mentioned. Thereafter a heavy layer of absorbent cotton is passed completely around the joint, providing the so-called "muff dressing." Two gauze bandages are then applied with the limb in complete extension, and pressure enough is made thereby to make the dressing exceedingly snug. (12) The tourniquet is then released. (Figs. 2-15.)



FIG. 2.

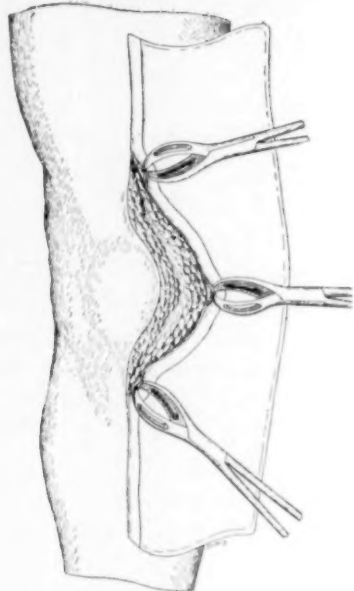


FIG. 3.

FIG. 2.—The skin incision around the margin of the patella.
FIGS. 3 and 4.—The shaped toweling attached to the skin edges.

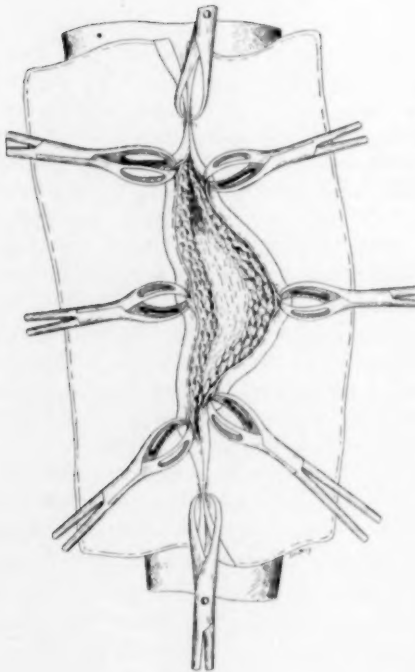


FIG. 4.

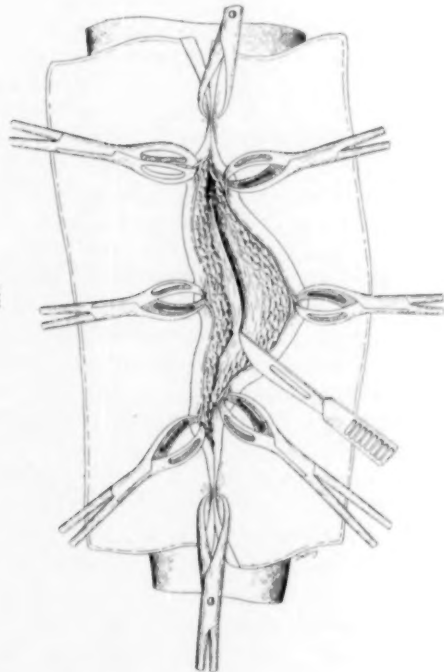


FIG. 5.

FIGS. 5 and 6.—The capsule incised.

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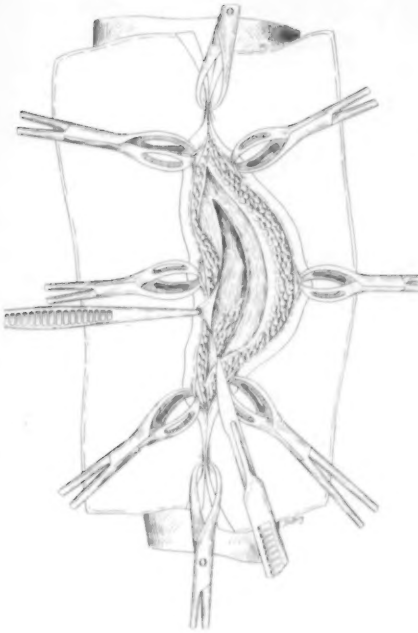


FIG. 6.

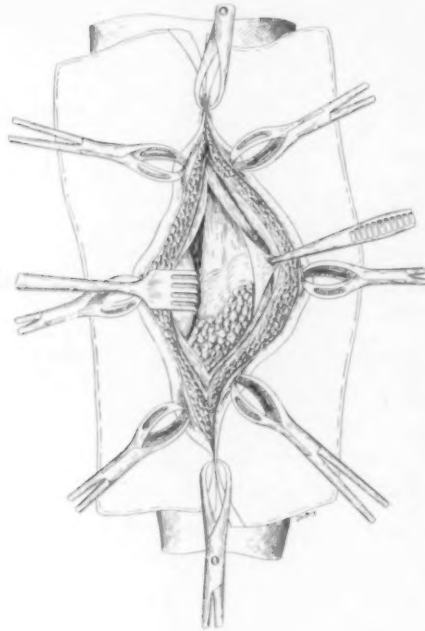


FIG. 7.

FIG. 7.—The patella retracted.



FIG. 8.

FIG. 8.—The knee flexed, showing joint contents.

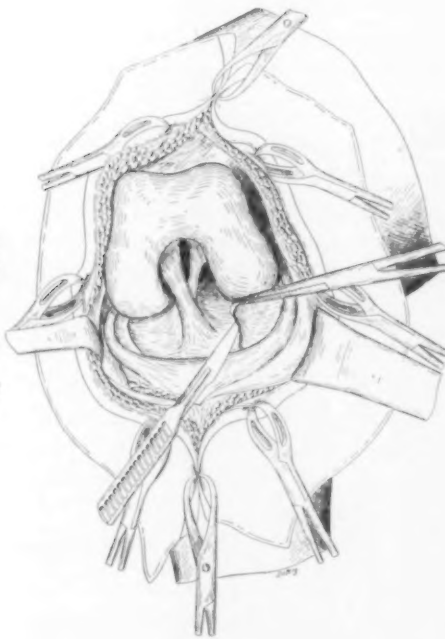


FIG. 9.

FIG. 9.—Removal of internal semilunar cartilage.

The immediate post-operative care consists in leaving the limb in complete extension on two pillows until the patient recovers from the anæsthetic. Thereafter each two hours, from 8.00 A.M. to 8.00 P.M., the patient is instructed to move the joint as freely as possible. Instructions are also given to shrug the knee-cap and to make every effort to lift the extended limb off the bed. Usually on the third or fourth day the patient is urged to bend the knee over the edge of the bed, and ordinarily on the fifth or sixth day walking is permitted, at first using a chair or other form of support, but, as already stated, no crutches are allowed. The stitches are usually removed on the seventh or eighth day, and when the dressing is inspected, it is quite surprising to note the freedom from post-operative hæmorrhage, and, likewise, the absence of post-operative swelling. After the stitches are removed, a cross-strapping of adhesive plaster is usually employed.

Statistics.—Males, 129; females, 57. Oldest patient, 69 years; youngest patient 9 years. Internal semilunar injury alone, 78. Internal semilunar injury plus hypertrophic associates, 108. Lateral arthrotomy, 15; median arthrotomy, 23; medio-lateral arthrotomy, 150. Internal and external semilunar injury, 2. Osteochondritis desiccans, 5. Cysts of semilunars, 3.

End-results.—In general, the writer would state that there is no form of operative traumatic surgery in his service in which the outcome is more uniformly satisfactory, and over half the cases have been followed a year or more. There have been four cases of superficial infection in the nature of subcutaneous hæmatoma or stitch abscess. There has been no intra-articular infection, and the healing process has been exceptionally smooth throughout the series. In every case there has been maintenance of knee-joint action, and in the vast majority the range of motion has varied between 180° extension and 110° flexion. In one recent case the entire suture line broke open on the eighth day, exposing the interior of the joint in much the same way that a laparotomy incision will occasionally tear asunder. This case—the most marked manifestation of hypertrophic synovitis in the series—was that of a sixty-year-old police sergeant, and after resuture primary union was obtained with a range of motion of from 180° to 100° . Many of the patients have been athletes, and numbers of them have been able to continue such sports as football, tennis and hockey after the operation without any apparent discomfort or embarrassment. This is particularly true in the group in which there was early restoration of quadriceps activity, a feature which has been stressed above. There was one death already reported in the first series as due to embolism.

The average period before resuming light work is eight weeks from the date of operation, but in many coöperative patients this period can be much shortened.

CONCLUSIONS.—The features already stressed in 1925 as to knee-joint arthrotomy are again emphasized, namely:

- (1) The surgical knee is a type of monarthrititis initiated by trauma, but often activated or aggravated by distant infection.
- (2) The internal meniscus is more often involved than any of the other

KNEE-JOINT ARTHROTOMY

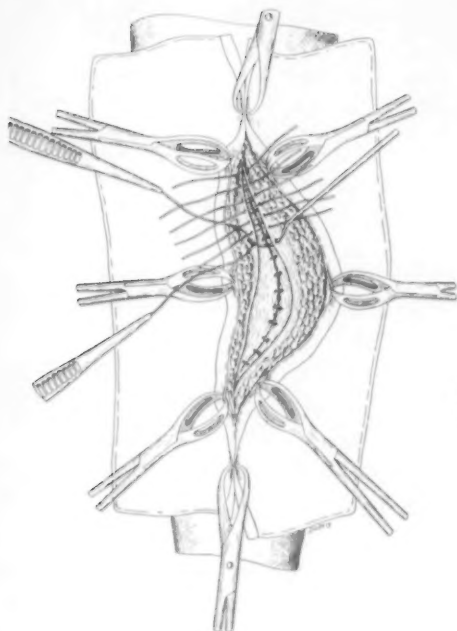


FIG. 10.

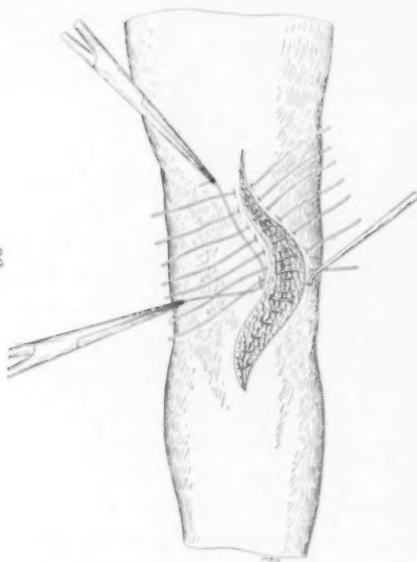


FIG. 11.

FIG. 10.—Closure of capsule and muscle-fascia layers by interrupted catgut sutures.
 FIG. 11.—Skin closure by interrupted sutures of dermal material.

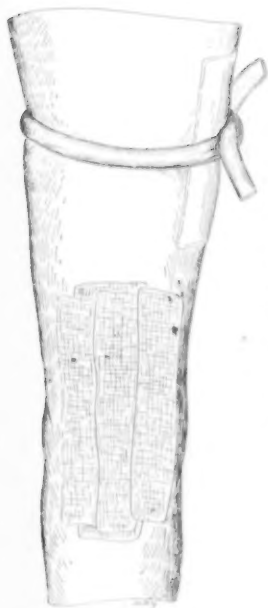


FIG. 12.



FIG. 13.

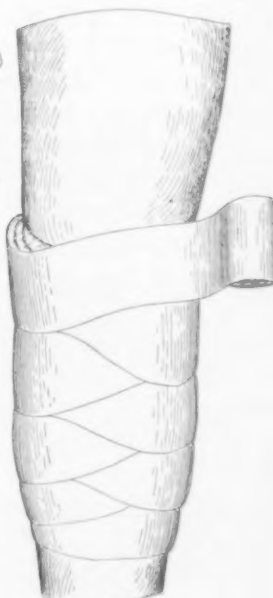


FIG. 14.

FIGS. 12 and 13.—Gauze and heavy cotton "muff" dressing.
 FIG. 14.—Bandage and removal of tourniquet.

structures; the next commonest findings are hypertrophied fat pads, villous excrescences, and bone fragments.

(3) The cardinal signs are pain, synovitis, and joint limitation; to these are often added atrophy, joint instability, and crepitus.

(4) X-ray examination is of positive value only when the arthroliths are calcified.

(5) The history and examination usually present a fairly typical picture so that patients fall into three groups (acute, subacute, and chronic) as to age in years and age in pathology.

(6) Arthrotomy, limited or general, is notably effective in a selected group of patients.

(7) After-treatment by active mobilization is an important feature.

(8) The ultra-aseptic (Lane) technic has given primary union in this series of 186 cases with the exception of four with superficial infection.

(9) Arthrotomy does not contraindicate future joint activity, even in athletes, if the articulation has not been too greatly damaged prior to operation.

(10) Accumulating experience indicates that general arthrotomy is a wiser procedure than limited arthrotomy, and, hence, this latter type of approach should be reserved for early cases, or those in which the diagnosis is relatively certain.

(11) The length of the incision is no bar to free active mobilization, and with any form of approach the patient can, with safety and profit, be encouraged to walk within the first week.

(12) The analogy between intra-abdominal lesions and intra-articular knee lesions is very striking as to symptoms and treatment.

(13) Recurrent synovitis is usually more due to intrinsic than extrinsic causes, and relief therefrom is more certain by surgery than by physiotherapy, apparatus or drugs.

(14) This series of 186 cases has emphasized the importance of surgical attack early rather than late, and the prophecy is made that, with accumulating experience, exploratory arthrotomy will acquire the same vogue as exploratory laparotomy.

(15) Except as to minor details, there has been no change in the operative technic described six years ago.

(16) The diagnosis is usually made by the history, and in the vast majority of cases the X-ray and the arthroscope are not necessary aids.

(17) We remain partisan to the use of the tourniquet, ultra-aseptic hands-off technic, early mobilization, and stress the necessity for overcoming atrophy of the quadriceps.

AN OPERATION FOR RECURRENT INFERIOR RADIOULNAR DISLOCATION*

BY ELDRIDGE L. ELIASON, M.D.

OF PHILADELPHIA, PA.

DISLOCATION, complete or incomplete, of the lower extremity of the ulna is by no means a rare or unusual condition. While it may occur as a result of joint destruction secondary to arthritis, bone disease and suppurative conditions of the hand and wrist, it most often is secondary to trauma. As a rule, the causative trauma is that incident to a fall on the heel of the hand, with the resultant bone injury commonly spoken of as Colles' fracture. In addition, however, to the fracture of the radius, further soft-tissue injury occurs, incident to the continued force transmitted through the hand.

When the radius breaks, the lower fragment is driven backward and upward. The lower end of the ulna not articulating against the carpus is not affected by the end on force, but is affected by the secondary supination and lateral strain incident to the upward and rotating dislocation of the carpus attached to the lower radial fragment. To permit this displacement from the ulna, either the ulna styloid must fracture near its base, carrying with it the ulna attachment of the intrinsic triangular ligament, the whole then displacing with the carpus, and hand, or the styloid holds fast and the triangular ligament ruptures at its radial attachment and secondarily the extrinsic or anterior and posterior inferior radioulnar ligaments suffer injury. By far the greater proportion of the subsequent disability in these fracture cases is due to the incident derangement of the joint relationship rather than to any bone deformity *per se*. Although the above combination of injuries is the usual condition of affairs, luxation of this joint does occur without bone injury. This may be a result of chronic oft-repeated trauma, causing the so-called luxation described by Gayraud (quoted by Milch) or the condition referred to as Madelung's deformity.

In young people, with more or less elastic bones, acute trauma may result not in fracture but in a tearing of the above-mentioned ligaments with a consequent luxation, usually anterior, of the lower end of the ulna. Although the literature is replete with considerations of dislocations associated with disease or fracture, there are comparatively few—approximately fifty cases reported—of uncomplicated anterior dislocation.

Cotton and Brickley, in 1912, reviewed the literature and found that the first case reported was a post-mortem, one by Desault. The next reference was forty years later, by Dupuytren. From that date until 1907 twenty-six references are reported. The reader is referred to the above excellent article

* Read before the Conjoined Meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, February 10, 1932.

for the bibliography up to this time. Since then some twenty more cases have been reported. Milch, in 1925, gave an admirable presentation of the subject to date, together with a description of a very ingenious and cleverly conceived operation for a correction of the condition. It cannot be determined, however, that he ever employed the procedure on a living patient. Painstaking examination of the data at hand discloses the fact that many surgeons have attempted various methods to correct this troublesome condition. Von Mayer advocated the use of an external band, Hoffa employed wires between the bones, Darrach resected the lower end of the ulna, while other text-book authorities advised an osteotomy of the radius in an attempt to tighten the relaxed ligaments. Behrend reports a case in which he obtained a good result following nailing of the two bones together. Mitchell reports a bone graft used in one case associated with a fracture of the ulna styloid. Wilson and Cochrane employed a fascial graft to repair the triangular cartilage. Bogнар, in 1930, reports two cases in young adults in which he used a fascial sling passed around both bones as a cuff. One would gather from the article that this was patterned after Milch's fascial cuff, except no mention is made of threading the radius. In one of the patients, Bogнар used a fascial graft from the styloid of the ulna to "the adjacent metacarpal bone." The first case had a good result for two years; then, incident to a fracture, the dislocation recurred. The second case was only four weeks old at time of report.

It will be noted from the above that there are various treatments reported, in some instances with successful results; in others the results are not mentioned. Most of the methods available for reporting were such as to preclude any possibility of a complete return of the function of forearm rotation, together with anatomical perfection, witness the nail, the wire, the bone graft, excision of the ulna, *etc.* However, two writers, Wilson and Cochrane, and Bogнар, report fascial employment successfully used in patients, while Milch suggests, as stated, a fascial sling. This author uses a fascia slip eight inches long and one inch wide, and by means of four incisions and drill holes on the anterior and posterior aspect of the radius, throws the cuff sling around the two bones.*

Influenced to a great extent by this latter article, the present writer, after a study of the three ligaments concerned, was convinced that the simple cuff of fascia was not sufficient, with the drill holes so far afield in the radius as described by Milch. The sling, to be sufficient, should simulate as near as possible the attachment and action of the triangular ligament. If, therefore, the sling would permit the ulna to rotate within it as the head of the radius

* Dr. C. L. Lowman informs me just recently that he used a fascial sling with good results in a case of Madelung's disease. Dr. Kellogg Speed reports to me that he has recently used the same type fascial sling with good results in a dislocation incident to a Colles' fracture. Doctor Milch, whose article is referred to above, writes that although he himself has never done this operation on a patient, nevertheless his ideas have been carried out by Continental surgeons several times with success.

RECURRENT INFERIOR RADIOULNAR DISLOCATION

rotates within its ligament, and if it could be attached to the radius approximately at the site of the triangular ligament attachment, a nearer approach to the ideal would be obtained. Furthermore, appreciating the fact that extreme supination has been shown not only to tear the anterior radioulnar ligament but also to tear the triangular ligament away (Fig. 1) from the radius, one would naturally be influenced to attach any new support as far posterior as possible to the plane of the radioulnar joint in order to counteract this forward tendency. Hence, the posterior position of the drill hole in the mesial aspect of the radius as shown in Fig. 2. Furthermore, it is readily seen that a sling of this sort will merely maintain approximation; hypersupination must be combated by repair of the extrinsic ligaments in addition. Fig. 3 will illustrate these points better than text can describe them.

With the above experiences of others in mind as well as appreciating the points in surgical anatomy as outlined above, the following case is here reported. It is of interest to note that this patient is a young nurse and that the condition is reported several times as occurring in hospital nurses. In two instances the injury occurred by forcible supination while in the act of restraining a patient.

CASE REPORT.—G. N., a nurse, aged nineteen years, was admitted to Service C, University of Pennsylvania Hospital, May 25, 1929, with the complaint of weakness and some dull pain in the left wrist. She gave the history that while cleaning a bathtub six months previously she slipped and fell on her outstretched hand. She consulted a physician at once and his clinical and X-ray examination disclosed no fracture. Since that time, although not completely disabled, the patient states that the wrist has become progressively weaker, less to be depended upon and somewhat more uncomfortable as a result of a dull ache.

Physical examination revealed little of importance as far as the present complaint is concerned except that on supination of the left forearm the lower extremity of the ulna dislocated forward completely at the inferior radioulnar articulation. At the same time, it was noted that pressure with the examining fingers between the two bones disclosed an abnormal laxity of the common attachments, permitting an unusual lateral separation of the bones at this joint. The diagnosis, confirmed by X-ray, was that of a recurring dislocation at the inferior radioulnar articulation. For relief the following operation was done:

An incision was made over lower end of the left radius, and the bone exposed by retraction of muscles. The radial nerve was identified. Incision was then made on the opposite side of the forearm over a corresponding part of the ulna, which was also exposed. With the aid of blunt dissection, an aneurism needle was carried around the



FIG. 1.—Illustrates diagrammatically the torn triangular ligament with the resultant separation of the two bones.

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ulna, perforating the pronator quadratus muscle. In this manner, two loops of heavy silk were passed around the bone. The ulna was now dislocated forward and the radius was then drilled in an oblique direction from its posterior and ulnar aspect forward and outward to penetrate the outer radial cortex about one and one-half inches above the styloid process. The drill used was slotted so that a loop of silk could be passed through the drill hole as the drill was removed. At the same time a probe was passed along the drill.

An incision was made in the outer aspect of the left thigh, exposing the fascia

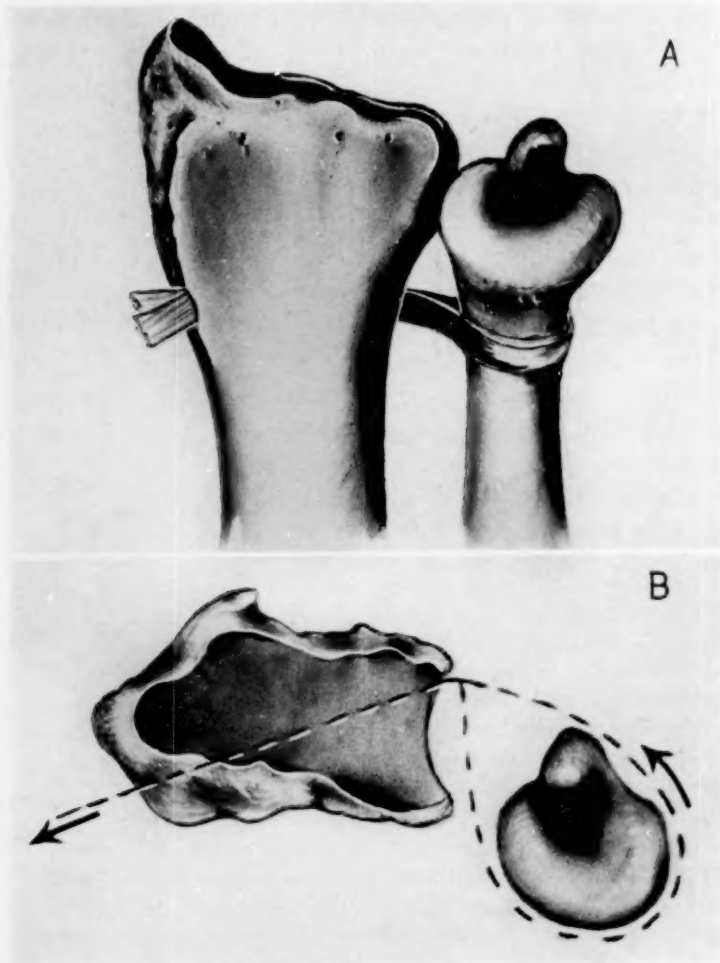


FIG. 2.—(A)—Illustrates the position of the fascial sling. (B)—The dotted line shows the direction taken by the drill hole, the arrow indicating the direction of the pull when the sling is tightened.

lata, a strip of which, eight inches long by one-half inch wide, was removed. The defect in the aponeurosis was sutured by both continuous and interrupted sutures of iodine gut, and the skin closed with interrupted silk sutures and clips. Using the silk loops, the fascial strip was drawn about the ulna so as to encircle it and serve as a sling. The two ends of the fascial sling were drawn through the drill hole in the radius separately, one being threaded through the probe; the other placed in the loop of silk. When the two ends of fascia were drawn taut at this stage of the operation, the ulna was held in

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FIG. 3.—Illustrates the fixation of the fascial sling ends on the radius and also the plication of the anterior ulnar ligament.

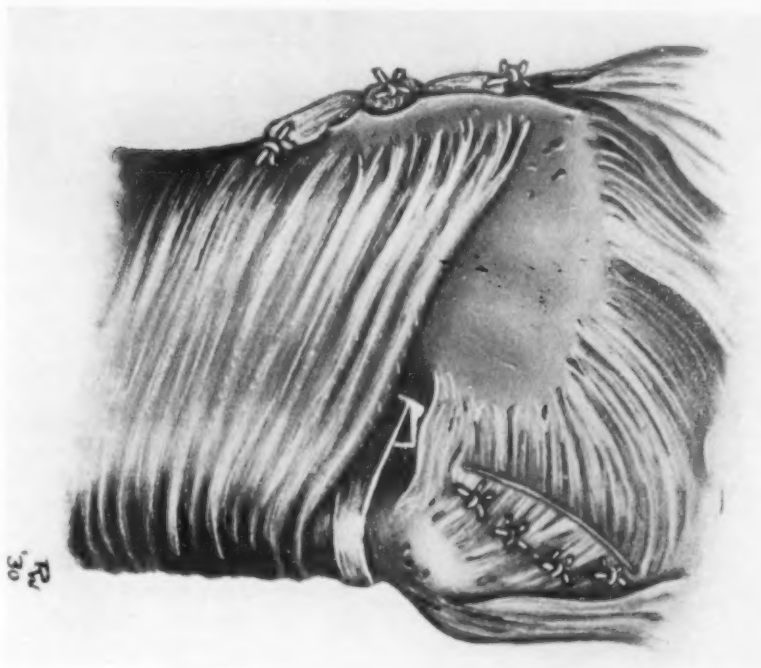
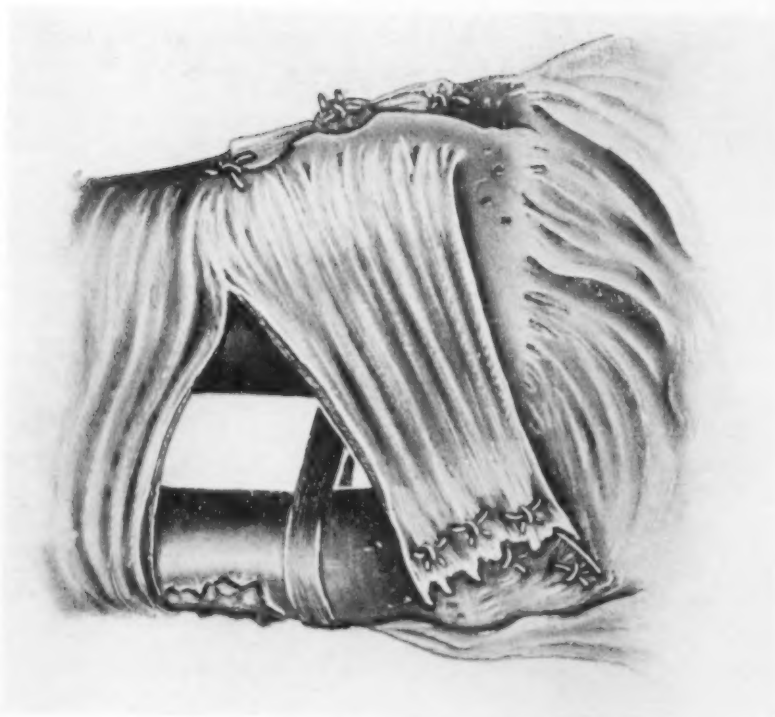


FIG. 4.—Illustrates the transfer of the distal portion of the pronator quadratus muscle.



position and did not dislocate. The free ends were passed around the tendon of the supinator longus very close to its insertion. The two ends were then tied together and a suture placed through the two ends of the knot and through the tendon to prevent slipping. The sling suspension of the ulna was tested at this point and found to operate satisfactorily. The skin was closed with a continuous silk suture and the arm was dressed upon an internal right-angle splint.

The patient had an uneventful recovery and when examined for the follow-up record six months later had a perfect functional and anatomical result. A short while after this report the patient stated that while restraining a post-operative case recovering from a general anæsthetic, her wrist was acutely and forcibly supinated with resultant pain and disability. Examination revealed a subluxation forward of the lower end of the ulna although the laxity and the laterally increased motion which was evident between the bones, the result of the first injury, was not evident at this time. In other words, the two bones were held snugly together, laterally, but the ulna on supination slipped into a partial forward luxation.

Impressed by studies of dissected anatomical specimens as well as by the statements of anatomists that although the triangular ligament maintains the normal lateral approximation of the two bones, the anterior and posterior, radioulnar ligaments are chiefly concerned in preventing excessive, backward or forward displacement of the lower end of the ulna during pronation and supination, it was felt that the first operation only partially corrected the trouble, by the sling substitution for the triangular ligament. A second operation, therefore, to shorten the extrinsic ligaments was advised and undertaken December 6, 1929. The previous incision over the ulna was reopened, the scar being excised. The ulnar vessels and nerve were located and displaced toward the radial side. The external joint structures were cleared as well as the site of the previously placed sling of fascia lata. The latter was found intact, snugly fitting around the shaft of the ulna, about which it slid smoothly, during rotation of the forearm. Macroscopically, its appearance differed in no wise from normal living fascia lata. The subluxation appeared to be permitted by reason of a greatly stretched, anterior, radioulnar ligament. An incision was made through the anterior ligament into the joint. The slack of this ligament was then taken up by overlapping or plicating with interrupted chromic catgut sutures. (See Fig. 3.) A similar procedure was carried out on the posterior ligament. To further the approximation factors between the two bones a portion of the ulnar attachment of the pronator quadratus muscle was shifted distally and sutured over the joint as an additional splint. (Fig. 4.)

Following this second operation, a wristlet was worn for six months and the patient warned against extreme or forcible supination. When last examined, a year and a half later, the patient reported an excellent result, with freedom from discomfort and weakness. Physical examination revealed some slight anterior excursion on extreme supination.

Comment.—An operation has been described for anterior recurrent dislocation of the lower end of the ulna uncomplicated by bony deformity due to fracture or disease. In the reported case, this operation was performed in two stages. The second stage was made necessary because the true condition of affairs was not entirely appreciated at the first operation. Should a second case of this type come to hand, the entire procedure might best be accomplished with one operation.

The procedure is a very simple one. The approach incisions are safely removed from all important structures and no tendons or nerves need ever be jeopardized. The construction appears to be on a sound anatomical and functional basis.

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DISCUSSION—DR. WILLIAM DARRACH (New York) agreed with Doctor Eliason that it is an unusual condition very rarely occurring by itself. The development of such a condition with Colles' fracture is very common. A fairly high percentage of Colles' fractures complain of pain on supination and pronation, which may last for many years. Mechanics suffering from this condition have sharp jabbing pain, sometimes causing them to drop their tools into the machinery. Women patients complain of pain on wringing clothes. At the suggestion of Dr. Kirby Dwight, a method of treating this condition was tried which seems to put an end to the symptoms, namely, removal of the lower end of the ulna. The speaker has performed this operation now in over sixty cases and most of them have given a satisfactory result. Doctor Murray has also done these cases. The lesion is not only that the lower end of the ulna tends to rotate forward or back because the fibrocartilage is ruptured or the anteroposterior ligaments ruptured, but because of the relative shortening of the radius. Anything that shortens the radius will give derangement of the lower radioulnar joint. In some very bad Colles' fractures with the lower end of the ulna entirely out of contact with the radius, there may be almost no symptoms at all on pronation and supination. If the bone is not in contact one gets no symptoms. It is only in the milder cases of shortening of the radius that the severe symptoms follow. His procedure is to go in from the outer side, split the periosteum, bite the bone across, remove the lower portion of the ulna leaving the styloid process, and close the periosteum. Wait three days and then mobilize. The periosteum is left so that the styloid maintains its connection with the remaining portion of the ulna. There is rapid return of function. An experience of over twenty years convinces him it is a sound procedure, removes the pain, removes the deformity, and does not interfere with the strength or usefulness of the wrist.

DOCTOR DWIGHT (New York) said that he has used the operation Doctor Darrach described a number of times after he did the first one and found that it relieved the patient of such symptoms as pain on extreme pronation and supination, and of deformity. Doctor Eliason's procedure is perhaps a better operation in those cases in which the dislocation of the inferior radioulnar joint is not accompanied by a shortening of the radius. With fractures of both bones of the forearm we always try to get end-to-end reduction of the shaft of the radius, even if we can not do the same for the ulna. Apparently there are no such symptoms from relative shortening of the ulna as from shortening of the radius.

DR. A. BRUCE GILL (Philadelphia) remarked that the case presented by Doctor Eliason illustrated one type of inferior radioulnar dislocation. It is

RECURRENT INFERIOR RADIOULNAR DISLOCATION

due to traumatism and is not associated with any defect of the bones. Another type is that which is due to or associated with shortening of the radius. This shortening may be a result of a fracture as mentioned by Doctor Darrach or may be due to defective development of the lower epiphysis of the radius caused by osteomyelitis which has interfered with its growth. The ulna outstrips the radius in its growth and its lower end is pushed downward and backward. Congenital defects of the radius also produce the same result. In Madelung's deformity there is relaxation of the radioulnar joint, posterior subluxation of the ulna, and frequently curving of the radius. This deformity of the radius produces a relative shortening. The cause of Madelung's deformity is not definitely known but occurs most frequently in individuals such as washerwomen, who do hard work with their hands, particularly with movements of rotation.

When this condition is due to a shortening of the radius the proper method of treatment is to shorten the ulna so that the two bones are made of normal relative length. The procedure which he employs for this is to make a linear incision through the periosteum of the ulna just above its lower extremity and to resect subperiosteally sufficient of the shaft to compensate for the shortening of the radius. The lower fragment of the ulna is brought into apposition with the upper fragment and the periosteum is sutured again over the point of fracture.

Doctor Eliason's operation is a rational one and it has given a very good result in this case. The object, of course, is to reinforce and strengthen the normal ligaments of the joint without producing limitation of normal motion. The problem here is the same which is met with in the sternoclavicular joint, the acromio-clavicular joint and the knee-joint. The use of a fascia lata suture of ligaments is probably the best means of accomplishing the desired end in all of these cases.

A STUDY OF THE CAUSE OF DEATH FOLLOWING BURNS

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THAT the primary cause of death in superficial burns is due to a circulating toxin liberated in the tissue at the site of the burn has long been held by numerous observers. Others, however, believe that the rôle played by a circulating toxin is a minor one.

Avdakoff,¹ in 1876, found that blood from a burned animal often caused the death of the second animal. He was among the first to suspect that a specific toxin entered the circulation after the burn. Kizanitzin² extracted a toxin from the blood, urine, and tissues of a burned animal and obtained no such substances from a normal animal. Pfeiffer³ isolated cleavage products of protein decomposition from burned skin. Vogt,⁴ working on rats and guinea-pigs, found after cross-circulation had been established between two animals that, if one were burned, both animals frequently showed hyperæmia of the abdominal organs and in many instances both died. Weiskotten⁵ observed the degenerative changes in the adrenals, and Bardeen⁶ described the alterations in the lymph-glands found at autopsy and both felt that a circulating toxin most likely caused these changes.

The chief proponents of the toxin theory in recent years have been Robertson and Boyd.⁷ They believed that a toxin consisting of primary and secondary proteoses is produced in the burned tissue of rabbits and that this toxin circulates in the blood. Whole blood was found to be quite toxic while blood serum exerted very little toxic effect. Underhill⁸ ascribed many of the deleterious effects following burns to the marked increase in the concentration of the blood. Blalock⁹ determined the amount of fluid that was lost in the subcutaneous tissues of dogs after burns. This fluid was found by Beard and Blalock¹⁰ to have almost exactly the same protein content as blood plasma and they believed the loss of blood plasma into the burned area to be the principal if not the sole cause for the shock that develops within forty-eight hours following burns.

The object of the experiments here reported was to determine whether or not the cause of death following superficial burns is due primarily to toxins circulating in the blood-stream.

METHODS AND RESULTS

Profoundly anesthetized dogs were used in all instances. They gave no evidence of pain during the course of the experiments. Three different groups of experiments were performed.

GROUP I.—*The Effects on the Recipient of the Transplantation of Burned Skin.*

In this group of experiments the burned skin from the abdomen and lower chest of dogs was transferred aseptically to normal dogs from which skin had been removed. In no one of the ten experiments was there evidence of viability of the transplanted skin. No evidence of toxæmia in the recipients was found.

FATAL BURNS—CAUSE OF DEATH

GROUP II.—*The Effects of Débridement on the Survival Period of Burned Dogs.*

In this group in all instances experiments on two dogs of approximately the same weight were performed simultaneously. The area of burned skin and the length of time that the heat was applied was approximately the same for both animals. Large amounts of morphine supplemented by ether at the time that the heat was applied were used as the anæsthetic. After intervals of time varying from twelve to twenty minutes the burned skin was removed from one of the dogs, while that of the other animal was not disturbed. The

TABLE I

The Effects of the Removal of Burned Skin on the Survival Period of Dogs

Series A. Skin removed

Exp. #	Weight Kg.	Duration of Burning Minutes	Area of Burn Sq. Cm.	Time Interval Between Burn and Removal Minutes	Mean Blood Pressure Mms. Hg.				Survival Period After Burn Hours
					Before Burn	After Burn	Before Removal	After Removal	
1	6.25	21	246	15	94	108	108	86	9
2	5.6	21	221	15	92	94	94	112	4½
3	3.7	12	144	20	62	62	62	60	2
4	7.4	21	293	15	86	40	40	20	½
5	8.8	15	175	15	130	140	140	126	14
6	8.5	15	173	12	90	112	112	100	15½
Average	6.72	17.5	206	15	92	92	92	84	7½

Series B. Skin not Removed.

1	6.35	21	258	No Removal	112	110			10
2	5.2	21	205	No Removal	26	44			12½
3	3.35	12	161	No Removal	80	94			7½
4	7.35	21	290	No Removal	106	90			4
5	8.43	15	166	No Removal	132	142			54
6	8.8	15	173	No Removal	126	150			15½
Average	6.58	17.5	206		97	105			17½

arterial blood-pressures of each were measured frequently and the survival period was determined. Six such "double" experiments were performed.

In most of the experiments the blood-pressure was slightly higher immediately after the animals had been burned than it had been before the heat was applied. The mean blood-pressure was determined immediately before and immediately after the removal of the burned skin. In five of the six experiments, the dog on which the skin was left intact lived longer than the one from which the skin was removed. In the remaining experiment, the two animals lived the same length of time. The average survival period of the dogs upon which débridement had been performed (Series A) was seven and one-half hours, while that of the other series (Series B) was seventeen and one-half hours. The results of these experiments are given in Table I.

GROUP III.—*The Effects of the Transfusion of Blood from Burned Dogs to Normal Dogs.*

In this group, consisting of fifteen experiments, blood from the femoral arteries of dogs which had been burned was injected into the femoral veins of normal dogs by direct multiple syringe method using aseptic technic. The duration of the burning varied from three to twenty minutes. The time interval separating the burn and the transfusion varied in order to study both the early and late effects of blood from a burned animal. This interval varied from one and one-half to ninety-one hours, the average being twenty-nine hours. In most of the experiments all of the blood that could be obtained from the donor was given to the recipient. The amount of this blood varied in the different experiments from 200 to 400 cubic centimetres. In two experiments the recipients were bled 200 cubic centimetres before they received blood from the burned dog. No matching or typing of the blood was performed. In most of the experiments the blood-pressure of the recipient was determined immediately before and after the transfusion, and after an interval of time varying from seventeen to twenty-four hours had elapsed. The blood-pressure cannula was then removed and the incision was closed.

Of the fifteen recipients one died immediately after transfusion. The blood pressure of this animal fell markedly after 200 cubic centimetres of blood were removed and it continued to fall when transfusion with blood from the burned dog was performed. In all experiments except the one just mentioned the blood-pressure of the recipient was higher after the transfusion than it had been previously. One dog died ten hours after the transfusion. Autopsy revealed thrombosis of the right femoral vein and a pulmonary infarct. These may or may not have caused the death. One dog developed bronchopneumonia. This animal was killed three days after the transfusion. The remaining twelve animals lived and showed no ill effects from the transfusions.

Discussion.—An attempt was made in these experiments to determine whether or not death after superficial burns is due to toxæmia. Robertson and Boyd⁷ found that rabbits which had burned skin transplanted to them developed toxic symptoms within an hour. In the present experiments the injured skin which was transplanted from burned to normal dogs showed no evidence of a blood supply having been established and simply sloughed off. There was no evidence of toxæmia resulting from the transplant. Dogs upon which débridement of burned skin was performed lived for shorter periods of time than animals of the same weight with burns of the same extent and severity in which the burned skin was not removed. Dogs do not blister when burned and weeping from the skin is inappreciable, hence the skin serves as a barrier against the loss of fluid. When burned skin is removed probably more fluid is lost than is the case when the skin is left intact, because the operation for the removal of skin is associated with the loss of a small amount of blood, and, too, a denuded surface remains from which fluid escapes. No definite evidence of the presence of toxins was obtained

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in the experiments in which whole blood from burned dogs was transferred to normal dogs.

Summary.—All of the experiments were performed on dogs that were profoundly anesthetized. Burned skin when transplanted to normal dogs did not remain viable and no evidence of toxæmia was found in the recipients. Dogs in which the burned skin was removed had a shorter survival period than others of the same weight with burns of the same extent and severity from which the burned skin was not removed. Whole blood that was transferred from burned to normal dogs did not cause untoward symptoms in most of the recipients.

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EMBOLECTOMY

REPORT OF A CASE INVOLVING THE FEMORAL ARTERY

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THE operation of embolectomy was first attempted by Ssabenejew¹ in 1895, but he did not find the embolus. Lejars² removed an arterial thrombus in 1902. Twelve embolectomies were done before George Labey³ did the first successful one in 1911. In 1912 Einar Key,⁴ of Stockholm, performed the first of his series of seventeen embolectomies on fifteen patients.

Reviews of the literature are given by Key,⁴ in 1922, quoting thirteen successes out of forty-five cases; Jefferson,⁵ in 1925, quoting twenty-eight successes out of seventy-three cases; Petitpierre,⁶ in 1928, quoting thirty-four successes out of 118 cases; and Key,⁷ in 1929, quoting approximately eighty-six successes out of 216 cases. At least fifty-two embolectomies have been done since Key's last review. Key's article in 1922 is the classic in the field of embolectomy and so great has been his influence that of the 216 cases collected to the end of 1927, 145 were done in Sweden. American and English reviewers agree on the preponderance of Swedish cases and Pemberton⁸ states that up to 1928 only twenty cases were reported in the United States and Canada.

Various instruments, including alligator forceps, Babcock's vein probes, uterine sounds, ureteral catheters, small urethral catheters, and Merke's cork-screw probes have been used to remove the emboli. In 1894, Severeanu⁹ suggested that in cases of amputation for gangrene due to arterial obstruction, a bougie might be passed up for some distance from the cut surface of the stump into the divided proximal end of the main artery so as to insure its patency, to remove clots, and to minimize the risk of gangrene of the flaps. We could find no report in the literature of using a large urethral catheter.

Despite the ultimately poor result, we are reporting the present case (1) because of the relative lack of interest in embolectomy outside of Sweden, and (2) because the embolus was removed in a new way.

CASE REPORT.—Mrs. A. S., aged sixty-four, white, housewife, with two children living and well, entered the Chicago Lying-In Hospital on November 12, 1931, with the complaints of a dropping sensation in the vagina, dyspnoea on slight exertion, and almost total deafness, all of several years' duration. The family history and past history were uneventful. She had reached the menopause at forty-seven and her three complaints had gradually developed since then. She had been seen once before in the outpatient department on October 5, 1931, when the symptoms and examination were the same as on entrance to the hospital.

The patient appeared older than she really was. There was a little dyspnoea when she was lying flat, but no cyanosis. The lungs were normal. The left heart border

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was in the anterior axillary line. There was a systolic murmur at the apex transmitted to the axilla and a systolic murmur at the base transmitted to the neck. The second sound at the base on the right was accentuated and there were frequent extrasystoles. The liver was just palpable and there was no fluid in the abdomen. Vaginal examination revealed an anterior and posterior colpocoele, uterine prolapse, and cervical erosion. The temperature was 98.0° F., the pulse rate 80, the respiratory rate 22, and the blood-pressure 194 systolic and 100 diastolic.

Course.—On November 16 there was some pain beneath the sternum and an electrocardiographic tracing indicated coronary occlusion and left axis deviation. On November 19 a La Forte colpocleisis was done under local anaesthesia. The patient improved after this operation until November 27 when she had severe pain beneath the sternum with nausea, vomiting, cyanosis, and a chill. The pulse was absolutely irregular and the blood-pressure, 150 systolic and 94 diastolic. A diagnosis of coronary embolism was made. Two days later she had a pain in the right chest with blood-tinged sputum, a friction rub, and a fever of 101° F. Again on December 8 she had blood-tinged sputum.

December 11 there was pitting oedema of the left leg.

December 12 there was pain in the left popliteal region. The dorsalis pedis pulsation was palpable.

December 13 there was tenderness over the left femoral vessels and in the left calf and a diagnosis of thrombophlebitis of the left leg was made.

December 14 the patient had great pain in the left leg. The skin below the knee became mottled and of a violaceous tint. The patient tossed about and was covered with cold perspiration.

December 15 she had a sudden attack of violent pain in the left leg at 11 P.M. The leg became colder and more mottled. It is believed that the embolism occurred at this time and that the symptoms during the few days just preceding were due to small emboli, or to the main embolus lying higher up in the artery without completely obstructing it. Key⁷ has shown that small emboli often precede the major one.

December 16 at 11 A.M. we saw the patient. The left dorsalis pedis and popliteal pulsations were not palpable. The leg was mottled to about 10 centimetres above the knee and skin temperature tests showed the maximum point of change to be also about 10 centimetres above the knee. A diagnosis of embolism of the left femoral artery was made and at 2 P.M., about fifteen hours after the lodging of the embolus, an arterial embolectomy was performed. Because of the palpable femoral pulsation just below the inguinal ligament, a popliteal approach was used.

Operation.—Under novocaine anaesthesia, a longitudinal incision about 15 centimetres long was made in the upper portion of the left popliteal fossa. The femoral vein was thrombosed and the artery empty and pulseless. The lower portion of the operative field did not bleed, but in the upper angle of the wound several vessels had to be clamped and more novocaine injected. The femoral artery was opened by a longitudinal incision about 2 centimetres long and a probe passed up the artery for 12 centimetres. A clot about 1 centimetre long came out with the probe. There was some liquid blood in the artery at the site of incision and below. A probe passed 12 centimetres down the artery met no obstruction. A No. 18 soft urethral catheter was then passed 24 centimetres up the artery. The catheter filled the lumen of the artery and the lower end of the catheter was clamped with a haemostat. It was then removed rapidly and acting like a piston, pulled out a smooth, grayish-red clot about 6 centimetres long. Almost immediately blood gushed from the arteriotomy wound and spurted several feet across the room (systolic blood-pressure varied between 115 and 145 during operation). At the same time numerous points in the operative field began to bleed. The arteriotomy wound was closed with two layers of continuous fine silk suture and was quite dry after closure. Arterial pulsation was palpable below the point of repair

of the artery. The vein was ligated. The wound was closed in the usual manner except that the popliteal fascia was not united.

Post-operative Course.—There was no palpable pulsation in the dorsalis pedis artery at any time after operation, but the femoral pulsation remained present. The day after operation the point of sudden change in the skin temperatures was about 15 centimetres below the knee. Two days after operation this point was about 5 to 10 centimetres below the knee and it remained there until the day before death.

December 18, two days after operation, several vesicles appeared on the foot.

December 20 pain sensation as determined by a pin prick was absent a hand's breadth below the tibial tubercles. There was a recurrence of pain in the right chest.

December 23 the foot and half the leg were purple and the toes shrunk. Several blebs had broken and were dusted with boric acid powder.

December 26 the skin stitches were removed. The wound had healed nicely and there was no necrosis of the skin edges.

December 28 the patient expired suddenly. At the time of death there was a definite line of demarcation about 15 centimetres below the knee. No necropsy was permitted.

Comment.—It is probable that the embolus in our patient was in the femoral artery at the point where the profunda femoris branches off. The catheter was inserted 24 centimetres above the arteriotomy and thus would approximately reach the junction with the profunda. This junction lies about 4 centimetres below the inguinal ligament and could be occluded even though the femoral pulse is palpable. Nordentoft¹⁰ states that there may be a pulsation directly over an embolus due to the downward thrust of the embolus when hit by the pulse waves from above. It is also possible that the upper end of the embolus might not completely obstruct the artery and thus the pulsations could go below the upper end of the embolus. It is also possible that at one time the embolus in our patient straddled the bifurcation of the aorta.

In using the large catheter, a snug fit is necessary. Embolectomy is often required in patients with pipestem vessels. Nyström¹¹ reported a case of forcing a false passage in a very arteriosclerotic vessel with a metal probe.

It is well known that one of the chief benefits of embolectomy may be in opening up the collateral circulation. This is especially true since emboli usually lodge at arterial bifurcations. In all of Lahey's four cases¹² and in 41.8 per cent. of Petitpierre's 118 cases,⁶ the embolus lodged in the femoral artery where the profunda branch is given off. It is almost as important to remove any secondary thrombi at the point of ingress of collateral circulation as to remove the embolus at the point of egress. Thus it would be important to have the openings of the genu superior arteries open as well as to have the profunda femoris artery patent in the case of an embolism of the femoral artery. It is possible that in our patient the profunda femoris opening was freed at the time of operation, but that a thrombus reformed in the popliteal region.

This case brings out several points emphasized by previous authors. It illustrates that arterial emboli may occur in cardiac disease, that removal of an embolus more than ten hours after the onset of symptoms usually does

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not restore the limb, that multiple emboli often occur, that the operation itself is not necessarily a difficult one, and, finally, that embolectomy may lower the apparent line of demarcation in an impending gangrene even if the entire extremity is not saved. We found that a large soft urethral catheter was effective in removing the embolus.

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EMBOLECTOMY WITH PARTIAL ARTERIAL OCCLUSION FOR EMBOLISM OF THE EXTREMITIES

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CARREL's classical experiments in arterial suture were a natural stimulus to operations for the removal of emboli blocking arterial pathways in human beings. Compared with some of his complicated vascular operations, the incision of an artery, removal of the clot, and the suture of the vessel appeared a very simple procedure from which excellent results could be anticipated. The literature soon contained enthusiastic reports with details on technic and indications. The operation appeared destined to be a vital contribution to the recovery of circulation and of limb in early cases of embolism in the extremities. Fewer and fewer reports on the operation have appeared in the literature in recent years; so much so that one gains the impression that a procedure with such great promise of brilliant results has been largely discarded. My purpose is not to revive interest in the original operation of embolectomy. I propose to analyze the reasons for failure, to present a somewhat different viewpoint, and a modified procedure that appears to offer an outlook for better clinical results.

The restitution of the arterial stream is the primary object of embolectomy and arterial suture. It is quite impossible to determine how often that has occurred in the reported cases. The saving of all or most of a limb is no evidence that a through circulation of blood has occurred at the site of the embolectomy. In fact, there are so few instances in which the explicit statement of a permanent return of arterial pulsation is made that it is fair to assume that there was no lasting through arterial stream after the great majority of the operations. Operations are often termed successful when no gangrene or only limited gangrene supervenes. The literature consists, for the most part, of individual case reports of this kind; the proportion of total failure to such successful outcomes is unknown. There are, however, enough instances of satisfactory results in the absence of through circulation at the site of suture to justify the operation on that basis alone.

The surgery of arterial embolism has obviously fallen short of the ideal. The reasons should now be considered. The customary argument is that the operation must be done early and that the sooner after lodgement of the embolus the operation is performed, the better the outlook for a result. This argument is based on the assumption that characteristic and recognizable symptoms occur at the moment the embolus becomes strapped in the vessel. I see no logical ground for this view. The embolus, usually lodged at a bifurcation or at the site of a large branch leaving the artery, should

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not in itself produce any significant clinical manifestations. It is only when the added thrombus becomes large enough to occlude the vessel that the characteristic symptoms should appear. The undetermined interval of time may render even an assumed early and favorably considered case a late one in fact. The hazards attending arterial suture after embolectomy, which will now be discussed, therefore apply with equal force to so-called early operations. The reaction in the arterial intima that has already occurred at the site of the embolism precludes the smooth type of repair after arterial suture that is seen in the experimental animal. Additional thrombi at the site of suture are probably inevitable. Their danger lies in the likelihood of dislodgement by the blood-stream and blockage at more distal sites. The more peripherally located the occlusion the less the chances for collateral circulation and the greater the chances for gangrene. In one of my cases at Mount Sinai Hospital a satisfactory immediate return of through arterial circulation followed removal of an embolus from the common femoral artery. Subsequently the pulses at the ankle disappeared, gangrene supervened, and the leg was amputated above the knee. Dissection of the amputated limb disclosed a recent large thrombus occluding the popliteal artery at its bifurcation. The danger of a dislodged thrombus attends any embolectomy with restoration of the circulation. Additional factors inviting post-operative thrombosis are the altered intima when arteriosclerosis or chronic valvular disease exists, and operations upon infected emboli. Under the last-mentioned circumstances an infected thrombus at the site of suture is of course potentially a much graver menace than the ordinary bland clot. The rôle of operative technic must also be mentioned. Massive thrombosis after embolectomy can be predicted if all the niceties of technic are not observed. In none of the cases in my experience was there restitution of the arterial stream when additional sutures to control leakage were required after the occluding clamps on a sutured artery were removed. Not only is a thorough training in experimental arterial work essential for the adequate execution of embolectomy, but also the opportunity for the performance of the operation occurs but rarely in surgical practice.

For all these reasons embolectomy with suture of the artery can only offer a small proportion of satisfactory results. Indeed, a careful reading of the literature leads to the conclusion that results would have been as good in not a few of the reported cases had operation not been performed. In my own experience of a dozen or more cases there is but one satisfying outcome to balance an otherwise unbroken series of failures. A girl suffering from mitral stenosis was operated upon shortly after the onset of symptoms of blockage of the popliteal artery. Permanent through circulation followed embolectomy and suture. The pulses at the ankle remain small and there are manifestations of claudication on prolonged walking. It is of interest to note that at the time this case was demonstrated I also presented a patient on whom I had operated at Mount Sinai Hospital, performing an obliterative aneurismorrhaphy for an aneurism of the popliteal artery following a gun-

shot wound. The operation was an urgent one because of gangrene of one toe and impending gangrene of the remainder of the foot. This patient attends to his occupation, involving much walking, without any symptoms, although his popliteal artery is obliterated. The failures in my cases of embolectomy were total failures, the customary amputation for gangrene being required in every instance. In retrospect there were two or possibly three cases that might have done better if operation on the artery had not been performed. It was the analysis of my own experience, and, in particular, the quoted case of proven detachment of a thrombus with blockage of the popliteal artery, that led me to take a more conservative view of the subject of embolectomy.

At the present time I believe that operation should be undertaken for embolism involving the arteries of the extremities only when the diagnosis and localization are certain and the evidence points clearly to the likelihood of massive gangrene if blockage is not relieved. A discussion on diagnosis is out of place. It can be said, however, that there should be a more general appreciation of the fact that the diagnosis is not always simple or the accurate localization of the embolus easy. I have operated twice for supposed embolism of the common femoral artery to find that the obstruction was at a much higher level, and on one occasion operated for embolism of the abdominal aorta at its bifurcation when the patient was later found to be suffering from widespread venous thromboses in both lower extremities. There must be clear clinical evidence that massive gangrene will occur if the embolus is not removed. In recent years I have observed several cases in which the decision to await further developments was made because such evidence did not exist. The early furious manifestations were followed by subsidence and by partial or complete restoration of circulation through collaterals (or possibly by canalization of the thrombus). I would call special attention to the saddle embolus at the bifurcation of the abdominal aorta. On the one hand the patient is usually in a state of severe shock and the operation is a formidable one. On the other hand I have seen instances of complete or partial restoration of circulation by awaiting developments. It is questionable in my opinion whether operation should ever be attempted on the abdominal aorta for an embolus lodged at that site.

There remain enough instances of embolism involving the arteries of the extremities in which the indication for operation is imperative. Having called attention to the reasons for failure in the ideal operation I wish to present a modified procedure and to report the case in which it was employed. The embolus with its surrounding thrombus is usually wedged in the long axis of an artery where the artery is angulated or narrowed by an important branch that is given off. If this branch could be saved for collateral circulation gangrene might be obviated. The branch is probably saved in the ideal operation at the risk of thrombi that can be swept into the peripheral distribution of the parent trunk. Theoretically, therefore, it would be better to remove the embolus, suture the incision in the artery, and ligate the artery

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below the branch. This, however, might force new-formed thrombi into the branch and render gangrene certain. It occurred to me that a solution of the problem would be an operation that can be generally employed and is not limited to those trained in the Carrel technic. The plan is as follows: After the exposure of the artery a liberal vertical incision is made over the thrombus on the side away from the branch. The incision is extended as freely as desired (particularly in the peripheral direction) so that the whole embolus can extrude without any manipulations. The lips of the wound in the artery are then broadly approximated by mattress sutures (of ordinary fine silk) that appreciably reduce the lumen of the vessel. With this technic minimal thrombosis should occur because of broad intimal approximation, and leakage at the suture line should not take place. The reduced calibre of the lumen would prevent peripheral dissemination of larger thrombi if they formed. Such thrombi would lodge in the narrowed artery below the branch and probably obliterate the lumen, leaving the branch free to carry collateral circulation. The closure of the lumen would probably be gradual, allowing some opportunity for the development of anastomosis. The plan was carried out in the following case operated upon at Mount Sinai Hospital:

A man seventy-three years old had been under treatment for two weeks for (a probable) auricular thrombosis. The course was satisfactory until 9 A.M., June 27, 1930. There was then a sudden onset of violent pain in the right hand and arm, the hand rapidly became bluish and cold, and the patient was soon unable to move either the hand or the forearm. His chief complaint was persisting severe pain in the right hand. There was cyanosis from mid-forearm down to and including the hand. The nails and fingertips were a deep blue. The whole extremity was cold. There was complete loss of function of the hand and wrist, partial loss of power at the elbow and shoulder. Sensation was also completely lost in the distribution of the ulnar nerve in the hand, and greatly reduced in the remainder of the hand. There was partial sensory loss over the forearm. The patient was suffering too severely to warrant mapping out the sensory fields. No pulsation was to be felt in the arteries at the wrist, elbow and arm up to the junction of the axillary and the brachial arteries. Here powerful pulsation was felt in the third portion of the axillary artery, ceasing abruptly at the lower border of the pectoralis major. The following is a transcript of the pre-operative note on the chart: With the diagnosis clear, the elapsed number of hours (patient seen at 1:30 P.M., that is four and one-half hours after the onset of symptoms) made the operative indication questionable. On the one hand the violent pain and apparently inevitable gangrene warranted an effort at relief. On the other hand the patient's advanced age and the possibility of other embolic phenomena were deterrent factors. It was, however, decided to perform an embolectomy with partial or complete obliteration of the artery, dependence to be placed on collateral circulation.

Operation was performed under local anaesthesia, six hours after the onset of symptoms. An incision was made over the lower part of the axillary artery and carried down over the upper portion of the brachial. The free margin of the pectoralis major was retracted. A large thrombus, broader below and distending the artery, could be seen as well as felt. Its situation obviously led to blockage not only of the axillary artery, but also of the branches from its third portion (the subscapular and circumflex arteries). The thrombus terminated below at the site of the superior profunda branch of the brachial artery. Dissection of the branches was not carried out. Serrefines were applied to the axillary and brachial arteries above and below the thrombus. A longitudinal

incision was made over the lower part of the thrombus and was progressively enlarged upwards so that the final opening in the artery was about 4 centimetres long. The thrombus began to extrude spontaneously upon incision of the vessel and broke off when about half had escaped. The upper serrefine was then released and the remaining half extruded, followed by a violent jet of blood. The serrefine was reapplied. The thrombus, about 5 centimetres long, was examined and found to be complete. The incision in the artery was then closed. Closure was by continuous mattress sutures making broad approximation of the intima. The arterial lumen was thereby narrowed by about one-half. When the serrefines were removed only a thin arterial stream could be felt below the suture line.

Directly after operation the hand and arm were less cold and cyanotic. A small radial pulse felt a few hours after operation was not perceptible the next day and at no time in the subsequent course was pulsation to be felt over the brachial or more peripheral arteries. The day after operation the pain in the hand and arm had disappeared, cyanosis was much less evident, the hand and arm were still cold, and there was beginning return of sensation. On the second day after operation there was considerable improvement in color and in the return of power. Four days after operation the hand and forearm were approximately normal. There was normal sensation and motion, and good color. The hand was warm, but not as warm as the left, and was also somewhat peler. The hand was normal one week after operation, when the patient was discharged from the hospital. Since that time there have been no manifestations referable to the arterial occlusion. The last report I have on the patient is one year after operation, at which time he was symptom-free as far as the right upper extremity was concerned.

Summary.—It is probable that the restitution of the arterial stream occurs only rarely after embolectomy and arterial suture.

So-called early operations for the removal of emboli may, in fact, be late ones.

The causes for failure are already existing changes in the arterial intima at the site of embolism, technical flaws at the time of operation, and the dislodgement of thrombi after operation.

Successful operative results are usually termed those in which gangrene does not supervene, but the same results might have occurred without operation in cases in which through arterial circulation did not follow embolectomy.

Operation for embolism of the arteries of the extremities is indicated only when the diagnosis and localization are certain and the evidence points clearly to the likelihood of massive gangrene if blockage is not relieved.

In order to reduce the chances of thrombosis and peripheral dissemination of thrombi after operation a modification of the customary operation is advocated, consisting in evacuation of the embolus and broad approximation of the arterial intima with resultant narrowing of the lumen. Its successful application in one case is described.

INSULIN AND SURGERY*

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THE advent of a therapeutically useful insulin has marked a definite advance in the progress of medicine. Since its discovery the treatment of diabetes and its surgical complications has been vastly revolutionized, with a concomitant marked improvement of the prognosis. As it has been aptly remarked, the researches of Lister and Pasteur made surgery safe for diabetics and it but remained for Banting, MacCleod and their co-workers to make diabetics safe for surgery. We are herein concerned with a consideration of the surgical aspects of insulin; while, undoubtedly, its greatest value thus far is in the management of diabetes, and the related non-diabetic acidosis, still there is every reason to believe that with further observations as yet unsuspected uses for this powerful substance will be found. Already it has been found of value in conditions totally unrelated to diabetes, though in all fairness it must be admitted that there is little evidence to support some of the claims that have been made regarding the therapeutic value of insulin in various and sundry conditions.

There is no more interesting and intriguing chapter in medical history than the absorbing story of the near-successes, the bitter disappointments that have marked the attempt to isolate the active hormone of the isles of Langerhans. Even before Langerhans had described the islets which have come to bear his name (1869), Cowley (1788) and the French physician Bouchardat (1845) had definitely shown the relationship between the pancreas and diabetes. Even after Minkowski and von Mering, in 1889, were successful for the first time (with the possible exception of von Brunner in 1683) in producing diabetes in the experimental animal by extirpating the pancreas, these islets were not incriminated as being related to diabetes. However, Laquesse's and Diamare's observations in the laboratory, and the mounting evidence collected by pathologists, finally convinced scientists that it was in these little pancreatic islands that the substance or hormone related to diabetes was produced. This substance was labeled "insulin" by Sir Sharpey Schafer, in 1916.

One of the most arresting episodes is the work of Zuelzer, in 1907. If he had not been too anxious to try his product clinically, in all probability insulin would have been available in 1908, or thereabouts. Recognizing that the pancreatic ferments destroyed the hormone of the islets (later called insulin), he made alcoholic extracts of the pancreas, not unlike the method used later by the Toronto workers. Using this product intravenously he got such severe reactions that its use was abandoned. We now know these

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reactions to have been the result of hyperinsulinism, and if the laboratory animal had first been used to standardize the product before clinical trial, they would likely have been avoided and the researches continued. Just think of the possibilities if insulin had been "discovered" in 1908 instead of 1922! Rennie and Fraser had, a number of years previously, in all probability isolated the hormone, but they unfortunately used it by mouth, and as is now well known, this destroyed the ferment.

It was not until 1921 that Banting, Best and later MacLeod and Collip initiated their researches which two years later resulted in the production of a commercially practical insulin. After its discovery it was immediately seized upon by clinicians not only in the treatment of the medical diabetic, but it was hailed as a saviour for the surgical diabetic. Calmer judgment has rationalized and more clearly systematized its use, has more definitely defined its limitations and dangers, though at the same time extending its scope of application into related fields.

As is well known, insulin is the active principle secreted by the pancreatic islands of Langerhans. There are, however, several other interesting features about it which are not as generally appreciated. While undoubtedly these isles are the chief source of this hormone, it has been found present in practically every structure of the body where carbohydrate metabolism occurs. Best and Scott⁵⁸ have prepared insulin from the submaxillary, thymus, thyroid, spleen, muscle, liver and other tissues, while Livierato⁷² has found it in the tonsil. It has been found⁵⁸ that the muscular system of a dog contains twenty times as much insulin as does its pancreas, the blood five times as much and the liver fully as much as the pancreas. This apparently indicates that insulin acts at the site of eventual utilization of carbohydrates. While some believe that insulin can be formed locally in the tissues, it is certainly more logical to suppose that it is formed in the pancreas and carried to the various tissues by the blood-stream. Undoubtedly the pancreas not only forms insulin but acts also as a storehouse: enough of the hormone can be recovered from a dog's pancreas that if re-injected it kills by a hypoglycæmic reaction. Substances apparently related to insulin have been isolated from yeast, onions and other vegetable sources. Collip²⁰ has called these related vegetable extracts "glucokinins," though it is not definitely known that these are identical with the product from animal sources.

As a matter of fact, a great deal more is known about *what* insulin does than about *how* it does it. Theories are legion as to its actions, what phases of metabolism are influenced, *etc.*, but while it undoubtedly does influence water metabolism, metabolism in general, as well as the digestion of fats and proteins, apparently its more important, and certainly its better understood function is its rôle in carbohydrate digestion, though its exact *modus operandi* remains somewhat obscured. Normally, the various carbohydrates are, in the process of alimentary digestion, ultimately broken down into the simpler sugars, or monosaccharides, chiefly glucose (dextrose). In this form it is absorbed from the intestines and passes through the portal circulation to the

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liver where it is synthesized into glycogen and stored. Apparently glycogen is, as required, broken down into glucose again, carried to the various bodily structures by way of the general circulation, and there resynthesized into glycogen and stored, where it is ready for immediate usage. Possibly glycogenolysis, or the conversion of glycogen into the simpler sugars, occurs continuously in the liver whether or not insulin is available (though Schmidt¹⁰⁷ and others have offered evidence to the contrary). Normally this glucose, which is thus thrown into the blood-stream, is continuously removed by the action of insulin in the various tissues of the body, where it aids in the removal of this glucose from the blood and its peripheral utilization. Insulin does not actually help burn the glucose; its action is probably anabolic in nature, converting the glucose from the blood into glycogen in the tissues, which is a necessary step before the sugar can be utilized. If insulin be lacking in the body economy, or if it be deficient, only partial utilization, or burning, of the glucose occurs, and its removal from the blood-stream does not keep pace with that thrown into the vascular system from the process of hepatic glycogenolysis. As a result, glucose accumulates in the blood in sometimes amazing quantities, and produces one of the most characteristic signs of diabetes mellitus, hyperglycemia. If insulin is supplied it apparently causes a "vacuum"—to use Joslin's term—in the tissues for sugar (as a result of carbohydrate utilization) which is replenished by removal of the excess from the blood, the blood sugar thereby dropping to within more normal limits. Obviously, since the "vacuum" or need of sugar is greater in the tissues of the diabetic than in the normal individual, insulin causes a relatively more marked drop in blood sugar in the diabetic than in the non-diabetic. Insulin probably acts as a catalyst, rather than actually participating in the digestive processes, as is indicated by the fact that it can be injected into dogs and recovered almost *in toto* in the urine while still exerting its physiological effect. Admittedly, such a conception of the mode of insulin action is not positively proven, but it serves well enough for clinical purposes.

The classical expression to the effect that fats burn in the flame of the carbohydrates has never been equaled for clarity in explaining the intimate relationship between carbohydrate and fat metabolism. As the sugars are digested, oxygen is liberated, which serves to oxidize (burn) the fats. If carbohydrate digestion is ample, then sufficient oxygen is available to completely oxidize the fats into the end-products: carbon dioxide and water. If, however, there is deficient carbohydrate metabolism there is not enough oxygen available to completely oxidize the fats, resulting in the formation of intermediary products, the so-called acetone bodies: acetone, diacetic acid and B-oxybutyric acid. As a result of the accumulation of these acid substances in the body, there develops a condition of acidosis. Quite obviously, such an acidosis may result when, due to lack of insulin, available carbohydrate in the body cannot be utilized, or it may develop in a condition where, though insulin is ample, there simply is not sufficient carbohydrate present

in the body, as obtains in starvation. In effect the result is the same: partial fat digestion because of lack of sufficient carbohydrate digestion.

There is a point which needs some emphasis, and it is that the acidosis is of much graver significance than is the hyperglycemia, which fact is sometimes forgotten. In fact, there is relatively little proof that the high blood sugar, in itself, is in the least harmful. Of much graver import is the acidosis and the cholesteremia resulting from faulty fat digestion. Hypoglycemia is a far more serious condition than is hyperglycemia and produces marked clinical symptoms; if the blood-sugar level be sufficiently low, a fatal outcome may develop.

As the result of the disturbed metabolism existent in diabetes mellitus, certain abnormal substances collect in the blood and are excreted, in part, in the urine, so that proper examinations of the urine and blood lead to a detection of this disturbance. As a rule, too much dependence is placed upon the urinalysis, both for preliminary diagnosis and subsequent therapy, and this may result in some untoward consequences. There are many pitfalls in the proper interpretation of the urinary findings, and only dire necessity should ever force a physician to attempt to treat diabetes without at least one blood examination. As regards these pitfalls: in the first place, it must be remembered that the amount of glycosuria in no manner necessarily reflects the true concentration of the sugar in the blood. Renal threshold is such a variable factor in different individuals, and even in the same individual at different times, that the sugar content of the urine will frequently be misleading. Numerous cases have been observed in which the urine has been free of sugar, though concomitant blood examination reveals a sugar content of .2 per cent. or more. Likewise, many examples of alimentary glycosuria exist, or cases of low renal threshold, in which there is no actual diabetes mellitus, though there be sugar present in the urine. Allan and Vanzant² report three cases illustrating that even a combination of ketonuria and glycosuria is not necessarily diagnostic of diabetes mellitus. If an individual has renal glycosuria, with a normal blood sugar, there tends to be a loss of sugar from the body with a resulting incomplete fat digestion, not differing in its manner of production from that seen in starvation, and a ketosis may develop with ketonuria. In such a case, the administration of insulin further lowers the available carbohydrate and aggravates the condition. Neither does the presence of ketone bodies in the urine necessarily indicate an acidosis. It simply means that there is a disturbance of fat digestion, and an incomplete destruction of the fat fractions, but it does not invariably mean that an acidotic condition exists, though the two are frequently associated. An interesting fact is pointed out by Marriott,⁷⁷ and it is that the so-called acetone test of Rothera, using sodium nitroprusside, is in reality a very delicate test for the presence of diacetic acid, being considerably more sensitive than the ferric chloride reaction. However, most text-books give the nitroprusside reaction as a test for acetone. Moreover, Starr and Fitz¹¹⁴ claim that in certain cases of diabetes mellitus a severe acidosis exists with excretion, not of

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acetone bodies, but of organic acids, not detectable by ordinary urinalysis. A severe acidosis may exist, then, without ketonuria.

Therefore, though urinalysis is invaluable in giving a clue to the presence of diabetes, the possible sources of error should be appreciated and guarded against, and confirmation by proper blood studies should be sought. Blood-sugar determinations are invaluable and should be the mainstay in the proper treatment of diabetes mellitus. Some observers¹²⁶ believe that cholesterol determinations are of more value than sugar determinations in the proper control of the diabetic, but this has not found very widespread application as yet. And in determining the presence or absence of acidosis, without question a carbon dioxide combining-power determination of the blood plasma is infinitely more accurate than a detection of the ketone bodies in the urine.

Insulin is marketed in this country standardized in units. This standardization is carried out by biological assay, that is, determination of the effect of a certain amount of insulin on a standard rabbit; more specifically, "the physiological unit at present is the amount of insulin necessary to reduce the blood sugar of a two-kilogram rabbit, deprived of food for twenty-four hours, to the convulsive level, 0.045 per cent., within five hours. The clinical unit is one-third of the strength of the physiological unit."⁵⁸ A unit of insulin thus determined is apparently rather consistent in its potency. However, it must be remembered that the fall in blood sugar is not necessarily proportionate to the amount of insulin used: that is, in proportion, smaller doses of insulin cause a greater fall in blood sugar per unit than do the larger doses. Estimates as to the glucose equivalent of each unit of insulin, that is, the amount of glucose metabolized by a unit of insulin, vary markedly, though the most generally accepted equivalent is about two and one-half grams of glucose per unit of insulin.

The only satisfactory way of insulin administration thus far developed which will have the proper and desired effect is by hypodermic. Though numerous attempts have been made to administer it intranasally,¹²⁵ through the skin by inunction,⁶⁹ under the tongue, by mouth, *etc.*, no satisfactory and reliable mode exists, unfortunately, other than by use of hypodermic injection. Of the three possible locations of making the injection, namely, intradermally (in the upper layers), subcutaneously, or thirdly, injection into the deeper fatty layers, the second, *i.e.*, subcutaneous injection, is the method of choice because it gives ample and consistent absorption of the insulin. Intracutaneous injection into the superficial layers, while acting more powerfully, is irritating and frequently causes an insulin "burn," apparently due to the tricresol added as a preservative; injection into the deeper fatty layers does not give uniform results. Intravenously injected, insulin exerts its influence rapidly and leaves the blood in two to four minutes. Subcutaneously, it reaches the maximum effect in about one hour after injection, continuing to act for about eight hours. This difference in action of insulin, depending upon which of these two routes is used for its administration, has been inadequately explained by Müller, *et al.*,⁸⁸ on the theory that

insulin acts only by stimulation of the cutaneous nerves, this effect being more marked and more prolonged by the subcutaneous than by the intravenous route. Different regions of the body are selected for the injections, the exact site being of little moment other than as regards convenience. Schmidt,¹⁰⁸ however, believes that certain tissues are capable of inactivating insulin by the action of proteolytic ferments, and he thus explains the occurrence of cases refractory to insulin therapy (*vide infra*).

It undoubtedly would be most desirable if a satisfactory method of insulin administration could be used in which a single, large dose might be given with a more gradual and prolonged action resulting. Such a method is claimed available by Strauch¹¹⁷ who uses a special oily preparation, an emulsion of water in oil, thus, according to him, permitting giving relatively large doses at infrequent intervals, each injection exerting its influence over a period of from five to seven days. Leyton,⁷¹ on the other hand, produces a similar, though less prolonged action, by dissolving the insulin in castor oil. Some¹⁷ reserve the use of the oily preparations for the graver forms of diabetes. These methods have not, as yet, found very widespread recognition, the more effervescent, watery solution still being the most universally used insulin.

Because the maximum effect of insulin is reached in one hour after subcutaneous injection, it is usually given one-half hour before a meal, as it takes the ingested carbohydrate one-half hour to be absorbed; thus the maximum absorbed glucose and insulin are present in the body at approximately the same time. Though most authorities agree that it is best to give insulin one-half hour before meals, some contend that the insulin should be evenly distributed every eight hours, regardless of meals.³⁸ Ordinarily, the aim sought is to regulate the patient so that two injections of insulin, before the morning and evening meals, will suffice.

Let us now turn to a more specific consideration of the usages of insulin in the surgical aspects of diabetes (mellitus). While we are herein more concerned with the surgical phases, it is easily understandable that there is no sharp dividing-line between the ordinary medical diabetic and the one suffering from surgical complications. Every diabetic is a potential surgical diabetic. Like Molière, "définissons nos termes." A surgical diabetic is generally considered to be a diabetic in whom has arisen a condition amenable to surgical intervention. Such a condition may either be part and parcel of the diabetic picture, such as arteriosclerotic gangrene of the extremities, or it may be simply coincidental, such as in the case of appendicitis. As Joslin⁵⁹ has said, patients do not die of diabetes today, they die of its complications. Generally, a surgical diabetic is a serious diabetic. Since the advent of insulin, coma is no longer the bugbear in the management of the diabetic; it is the cardiovascular degenerative changes which now exact the greatest toll among these unfortunates. Joslin has also made the statement that "already every other diabetic is a surgical diabetic before he dies," so the extreme importance of the subject is self-evident.

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There is no more impressive manner in which to illustrate the rôle that insulin plays in the surgery of diabetes than to compare the mortality in pre-insulin days with that of the Banting era. Weden, quoted by Joslin⁵⁸ had a pre-insulin operative mortality of 36.8 per cent., while his mortality since the introduction of insulin has been 16.6 per cent. Joslin's own figures do not show such a marked difference: between 1917-1923, his average mortality was 13.5 per cent., while since 1923 it has been 11.5 per cent. Lemann has found an insulin-era mortality of only 2.3 per cent. Bazin⁷ found a 2.74 per cent. mortality in diabetics with a 2.41 per cent. operative mortality in non-diabetics during the same period. White,¹²⁷ in a study of the records of the Roosevelt and New York Hospitals since the advent of insulin, found an operative mortality of 2.8 per cent. as contrasted with a 40 per cent. mortality prior to its use. Hauser and Foster⁴² vividly contrast the surgical prognosis of a diabetic thirty years ago and today, when at that time surgery was used only as a last resort in the presence of diabetes, while now no diabetic is denied surgery because of this disease. Truly insulin has made the diabetic safe for surgery!

There are several factors which are to be considered in any evaluation of the part that insulin has come to play in the treatment of the complications of diabetes. Whether or not it has any value prophylactically as regards surgical complications is not easy to determine. That is, whether or not the proper control of the medical diabetic, using adequate insulin to maintain him free from any marked hyperglycæmia, cholesteræmia, *etc.*, will prevent the occurrence of some of the complications is somewhat doubtful. Thus Wendt and Peck¹²⁶ believe that the adequate control will prevent many of the cutaneous manifestations such as furuncles, carbuncles, *etc.*, but express doubt as to whether it will prevent the vascular degenerative changes which account for many of the developments which add to the gravity of the diabetic state, such as gangrene, *etc.* As Warren¹²⁴ believes, susceptibility to cutaneous manifestations may be the result of abnormal glycogen deposits in the skin which are favorably influenced by insulin. The vascular changes that occur in a diabetic are identical with those of senility, but occur earlier in life due, according to many authorities, to a maintained high cholesteræmia. Certainly the proper control of the diabetes will not prevent senile changes occurring, whether it be in the blood-vessels or elsewhere, but it is logical to suppose that if it were possible to maintain a diabetic in an absolutely normal metabolic state (which is an ideal quite difficult of attainment) he would be immune from any of the degenerative changes occurring except as the result of natural senescence.⁶⁴ So there is at least some value prophylactically in the use of insulin, tending to some extent to prevent the development of some of the surgical complications.

Many are inclined to consider insulin a panacea, a cure-all, an excuse for carelessness of diet. There is no more pernicious thought prevalent today, regarding the treatment of diabetes, than that insulin is an excuse for negligence in the matter of dietary regulation. It most emphatically is not!

Its value lies in its use as an auxiliary measure. The proper attitude to assume is to attempt to regulate the patient's diet as though he were not to be given insulin, with, however, somewhat more liberality of diet than was permissible under the Allen régime; then, if on this definite diet the patient is unable properly to metabolize the food, insulin should be given in sufficient quantities. As a rule, many diabetics will remain sugar-free (urine) on dietary measures alone; and except in the severest cases, small doses of insulin will suffice to compensate for pancreatic insufficiency.

Of course, there is a bone of contention as to the relative amounts of fat, carbohydrate and protein to give, a consideration of which would lead us too far afield. However, some such as Sansum⁸ and Foster³³ give extremely liberal diets and use insulin in as large doses as are necessary to metabolize this excess food. Nevertheless, Joslin's reasons for attempting to use the small dose of insulin, necessitating more strict dietary control, are very convincing. He and many others believe that the proper approach is to diet the patient with a moderate undernutrition. And, as stated above, if on this diet the patient is still unable to metabolize correctly, sufficient insulin is supplied to take care of the excess carbohydrate, using relatively small doses of the hormone. "Diet is today, as it was in the Naunyn or Allen period, the bed-rock upon which all the superstructure stands, but, because of insulin, the diet of today is a much more satisfactory diet and the diabetic of today is a living and not a starving, dying diabetic."⁸

There has been, unfortunately, a great tendency among surgeons to shirk their responsibility in the management of a diabetic. While it is true that the proper management of such an individual, particularly one subjected to surgery, is an extremely difficult problem, still it is an unhealthy attitude for the surgeon to assume when he turns the patient over to his medical colleague and gives him the entire responsibility of preparing the case and giving the signal when to operate. There is nothing mysterious or incomprehensible about the management of such patients, certainly not as regards general principles. Of course, you can't treat a patient with general principles: he must have definite amounts of food and definite doses of insulin. The internist should be consulted, of course, his judgment should be given preference and he should largely be responsible for the details in the management of the patient. But the surgeon should coöperate and give intelligent attention to the patient even in the pre-operative and post-operative period. The problems which present themselves in these periods are not entirely medical, and if the surgeon leaves the internist to wrestle with the problem alone, the best interests of the patient are at stake, for the internist in his zeal to regulate the disturbed metabolism may lose sight of the surgical conditions which must be concomitantly handled.

Still another point should be emphasized: the necessity for individualization. Human beings are not built like machines, precise and exact in every detail, and just as there are no two individuals constructed exactly alike, so are there no two who function just alike. Everywhere in medicine we

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are cautioned of the need for individualization in treatment, and it certainly applies in the handling of the diabetic.

As in all surgery, there are two divisions of diabetic surgery: (1) The elective, and (2) the emergency. The elective subject, of course, offers the most ideal conditions. His problems differ little from that of the non-surgical diabetic. In this elective surgery, ample time is at hand to regulate the individual's diet and insulin dosage and to get him into the best shape possible before surgical intervention. Under these ideal conditions, the diabetic has almost equally as good chances as his non-diabetic brother, and insulin is largely responsible for this favorable outlook. In general, the management follows that of the ordinary, non-surgical diabetic, with the exception, however, that there is a more liberal use of carbohydrates and a consequent more liberal use of insulin, and an attempt is made to equilibrate the patient more rapidly than is ordinarily necessary. Children are not as frequent subjects for surgery as adults, but if they are, there is even a more liberal dosage of insulin, as even in the ordinary state of uncomplicated diabetes, insulin is used more freely than in adults, the necessity of which has been emphasized by Herold⁴⁶ and others.

The patient who is to be the subject of an elective surgical procedure is preferably admitted to the hospital several days in advance of the actual surgery; he is put to bed on a basic diet rather liberal in carbohydrates, such as approximately 1 gram protein per kilo, $1\frac{1}{2}$ to 2 grams carbohydrate per kilo and $2\frac{1}{2}$ to 3 grams fat per kilo, the latter being adjusted so as to assure a caloric intake of 20 to 25 calories per kilo, remembering that each gram of carbohydrate and protein yields 4 calories, each gram of fat, 9 calories.

If on this diet hyperglycemia or glycosuria persists, then sufficient insulin is administered to overcome it. The exact diet formulæ of Woodyat and others, so popular in the pre-insulin era, have largely been discarded. The proper handling of a diabetic is so individualistic that no general formulæ can be universally applied. It is more nearly a process of trial and error in regulating a diabetic's diet and his insulin; except that in the surgical diabetic there is less time for trial, and error is more likely to be a calamity than in the non-surgical case.

As Foster³² has said, every patient with diabetes who is operated on should be regarded as a candidate for coma, and its prevention is better than its cure. Thus the reason for a more liberal use of carbohydrate in these surgical cases is obvious, for it is in sufficient metabolism of sugars that we have our prevention or our cure of acidosis. While the possible pitfalls of depending upon the amount of glycosuria as an index for the amount of insulin required must be remembered, still, for practical purposes, if the approximate renal threshold is known from a preliminary blood-sugar determination, reliance upon the urinary "spill" is reasonably safe, if checked with blood determinations from time to time. Again, the regulation of in-

sulin is largely a trial and error proposition beginning with small doses one-half hour before meals, three times daily, and increasing the amount until the urine is normal or essentially so. Ohler⁹² has arranged a very helpful scheme for estimating the amount of insulin required, judged by the reduction of Benedict's solution by the urine. His plan is as follows:

No sugar	no insulin.
Greenish color	5 units of insulin.
Yellow-green color	10 units of insulin.
Brown color	15 units of insulin.
Red color	20 units of insulin.
Diacetic acid	20 units of insulin.

While the patient is being regulated dietetically, he should be thoroughly surveyed from a clinical and laboratory viewpoint, and finally, on the day of operation, he should receive an extra amount of glucose to combat any possible acidosis. This extra glucose may be in the form of oatmeal gruel, orange juice, *etc.*, or if there is a definite need for a larger amount of sugar, it may be given in solution, by vein. Sufficient insulin should be given concomitantly to metabolize this extra glucose, figuring about one unit of insulin for each two and one-half grams glucose given. Likewise, post-operatively, extra glucose should be given over and above that which is maintaining the patient.

The diabetic is not immune to other conditions which are only remotely related to diabetes and which are sometimes the object of elective surgery. Thus there is the question of tuberculosis in the diabetic. Ever since Richard,²⁹ in 1694, reported the occurrence of diabetes and tuberculosis in the same individual, it has presented a serious problem. While some have claimed that insulin aggravates a tuberculous condition,²⁵ by far the most eminent authorities agree that insulin has no particular deleterious effect on the tuberculous process and is greatly beneficial.^{29, 45, 58, 63} As the therapy of tuberculosis advances, more and more surgery is being advocated, such as pneumothorax, phrenic nerve surgery, thoracoplasty, *etc.* Since the advent of insulin, the tuberculous-diabetic individual need no longer be denied what benefits may accrue to his tuberculosis from surgical intervention.

A much more serious problem, however, is the management of the diabetic who must submit himself to an emergency surgical procedure. This emergency may be some complication of the diabetes, usually the result of cardiovascular degenerative changes, or an infection; or the emergency may be a condition unrelated to the diabetes, such as ruptured peptic ulcer, strangulated hernia, *etc.* If the patient is not actually in coma, it is undoubtedly best to disregard the diabetic condition, that is, for the time being, and treat the surgical condition first. Particularly in infections is it true that the surgical condition itself is frequently serving to aggravate the diabetes, and correction of this will often, in itself, serve to improve markedly the disordered metabolism. In the emergencies, diet is of no immediate concern, but it is advisable to combat acidosis and coma from the onset by the

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liberal use of glucose, by mouth or vein, with sufficient insulin to assure its metabolism. Even more so than in most cases, generalizations are impossible and each case must be a law unto itself. Greater reliance must be placed upon the laboratory examinations than is usually necessary. If time permits, blood-sugar and carbon dioxide combining-power determinations are valuable guides to the patient's condition and to the therapy indicated. If time is too pressing, glucose and insulin must be given based upon the urinary findings, perhaps following such a scheme as Ohler has suggested. To a great extent the exact quantity of insulin given is empirical. If the patient's general condition warrants it, the surgical condition is first eradicated and only then is attention turned to righting the metabolic disorder.

As has been pointed out, usually in these emergencies, though not invariably by any means, the diabetes itself is of a more severe grade; and if the patient is not in coma, he is frequently on its verge. It is always an ever-present sword of Damocles. So the one essential pre-operative measure is to combat any tendency to acidosis, by the liberal usage of glucose and insulin. Here again it should be emphasized that hyperglycemia, in itself, is relatively harmless, but not so hypoglycemia or acidosis. The significance of this, if appreciated, is an important guide to therapy, especially in an emergency: ample glucose should be given to be certain that the acetone bodies are oxidized when insulin is added, while at the same time making sure that there is enough glucose to more than react with the insulin, so that the patient is not thrown into the dangerous hypoglycemic state. Judged by the insulin given, it is much safer to give an excess of glucose than too little.

After the correction of the surgical ailment, particularly if it be in the nature of an infection, marked improvement in the disordered metabolism will be frequently noted, and the amount of insulin necessary to keep the urine free of diacetic acid and relatively free of sugar will be markedly less. Infections, such as purulent collections, serve in part to counteract the action of insulin, and after their drainage the amount of insulin required is usually decreased. Lawrence and McCance⁶⁸ report a case which would indicate that the inhibition of insulin action by infections and sepsis is not due directly to the sepsis or toxins, but to the accompanying febrile reaction. They likewise suggest that the need for more insulin may result from increased activity of the adrenals and thyroid, recognized antagonists of the pancreatic islets. However, Warren¹²⁴ believes that sepsis decreases the effect of insulin in maintaining a normal glycogen distribution and in this manner unfavorably influences the diabetic state. The therapy in these cases varies from hour to hour. As Joslin has emphasized, it is safer to give frequent, small doses of insulin rather than infrequent, large ones.

Too much blind faith must not be placed in insulin, trusting it to snatch our patients from the very jaws of death. Invaluable though it is, it will sometimes fail in the severest cases. So particularly in these cases of emergency, which are so often the graver forms of diabetes, the insulin must be supplemented by other measures, particularly ample quantities of fluid to

dilute and help excrete the acid substances.¹⁸ As Lemann⁷⁰ and others have emphasized, alkalies, in these severe cases, are not only useless but are actually harmful. Other than more energetic use of these auxiliary measures, and more frequent laboratory checks on the patient's condition, the post-operative handling of these cases differs not a great deal from those of the elective surgical group.

A fact which has been mentioned by a number of writers and should always be borne in mind is that a patient in diabetic coma may present a picture not unlike an acute abdomen. Abdominal pain and leucocytosis may be evidences of impending coma and it is perfectly possible to conceive that such a patient, falling into careless hands, might be mistakenly laparotomized. It has been suggested, though not proven, that the pain and leucocytosis may be due to a pancreatitis. Saunders¹⁰⁵ found in a series of eighty diabetic cases that this difficulty in diagnosis arose in two instances, but he doubts that a simple diabetic coma can, in itself, give the symptomatology of an acute abdomen.

As we have already intimated, numerous claims for the therapeutic efficacy of insulin in various and sundry conditions have been made. The value of this hormone in many of these conditions is questionable, to say the least. Almost the whole gamut of medical and surgical diseases has been experimented with in attempting to apply insulin therapeutically, including mental disorders, Parkinson's disease, cyclothymia, dermatoses, diphtheria,⁹ *etc.* However, we will attempt here to consider only the more important applications, particularly surgical conditions.

One of the most frequent conditions seen, especially post-operatively, is acidosis, non-diabetic in origin. For a number of years, the great value of glucose in the handling of this condition has been appreciated, and after the introduction of insulin, the analogy seemed obvious: Insulin and glucose is specific in diabetic acidosis, so why not in its near-relative, non-diabetic acidosis? But this is a question about which no definite agreement has been reached. That is, not only in acidosis, but in any condition where glucose is indicated, such as vomiting of pregnancy, liver disease, *etc.*, there has been a question as to whether or not insulin should be given routinely. Titus¹²¹ and Thalhimer¹¹⁹ have been two of the staunchest leaders of opposite schools, the former not believing insulin is indicated in non-diabetic conditions, the latter claiming that whenever glucose is given, enough insulin should be used to help metabolize it. As is usually the case, they are probably both right, and the need for individualization of cases is again evident; no one rule will cover all cases even of the same general class.

Those who believe that insulin should be given with glucose feel that the glucose causes a "strain," as it were, on the island tissue and may precipitate a diabetic condition, particularly if there is any latent deficiency of insulin. While this possible etiological factor has long been popular in diabetic discourses, there is no definite clinical proof that a normal, or even a diseased pancreas can be "strained" to such a point that the damage is irreparable, with an

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ensuing diabetic state. In fact, it is well known that if moderate doses of glucose be administered, not only is sufficient insulin liberated by the pancreatic tissue, but an excess is produced. If, in addition, exogenous insulin is administered, there is a very real danger of producing a hypoglycæmic state. So individualize. If urinalysis shows a constant "spill" after glucose administration, indicating hypoinsulinism, then moderate doses of insulin should be given with the next amount of glucose to aid in its combustion. It need hardly be stated that glucose should never be administered without a preliminary urinalysis, preferably a blood-sugar determination.

However, in cases of increased intracranial pressure, such as follows head injuries, unless the patient is actually diabetic, the administration of insulin is contraindicated: it is the hypertonicity of the blood produced by the glucose that is of benefit in reducing intracranial pressure; if insulin is given the glucose is so rapidly utilized that its value is extremely doubtful.

As for the routes of glucose administration, unquestionably the intravenous path is the most reliable. Rectal drips are quite popular with many, but there is considerable question as to whether there is very much absorbed in this manner.^{81, 82, 98}

Ever since insulin has been available clinically it has been used, apparently with good results, as a local applicant for ulcers, in non-diabetic as well as diabetic individuals. While originally it was believed that the local application of this hormone caused an improvement in the local tissue metabolism and hence a clinical improvement, the experiments of Nathan and Munk⁹⁰ have rather conclusively shown that any improvement is due to the acidity of the preparation, not to the insulin *per se*.

Disorders of menstruation seem rather a remote subject from that of insulin, yet rather encouraging results have been obtained in the treatment of some of these disorders with insulin. Those menstrual disturbances, whether excessive bleeding or amenorrhœa, which arise not from any organic change but rather from some ovarian dysfunction, respond very nicely to small, repeated doses of insulin. This substance apparently has a regulatory action on ovarian function, as has been particularly pointed out by several foreign investigators.^{23, 47, 123}

The question of malnutrition and the underweight individual while not strictly a surgical problem is of enough importance to warrant a brief consideration. The surgeon quite frequently has his problems of undernutrition and anorexia to deal with, and they are at times quite perplexing. Fonseca³⁰ has suggested that most cases of obesity are due to hyperinsulinism. He believes that the reason so many fat individuals become diabetic is that prolonged hyperinsulinism finally exhausts the island tissue.²¹ The German Falta is credited by Metz⁸³ with having, in 1925, introduced the use of insulin in malnutrition. There have been numbers of reports to the effect that small doses of insulin do stimulate the appetite and cause definite increase in weight, not only in otherwise normal individuals but also in patients suffering with malignancies, tuberculosis, etc.^{5, 16, 30, 91, 111} Presumably its

action is through the production of a hypoglycæmia, which in turn stimulates the appetite and increases the amount of food intake and accelerates its rate of utilization.

Insulin apparently has a definite effect on the gastro-intestinal tract, not only upon its motility but also upon its secretions, particularly those of the stomach. While it does seemingly definitely increase gastric motility,^{14, 112} its more important clinical application is its stimulating effect on the gastric secretions, both HCl and the ferments. This stimulatory effect on these secretions, with a consequent improvement in digestion, may be a factor in the benefits in malnutrition which follow the use of this substance. In the diabetic, this increased acidity, *etc.*, is probably beneficial, as Rabinowitch and his co-workers,¹⁰⁰ from a careful study of 100 cases, have concluded that, as a rule, gastric acidity is decreased in diabetes mellitus. Because of this increase in acidity caused by insulin injection, it is questionable whether it is advisable to use this hormone in cases of gastric ulcer; yet paradoxically, cases have been reported where insulin administration has seemed to quiet the gastric pain¹¹³ or actually cause the ulcer to disappear.³⁹ Still another danger, at least a theoretical one, of using insulin in ulcer patients, is that the pylorospasm which almost invariably accompanies such a condition may cause gastric retention of food, with insufficient carbohydrate absorption to buffer the insulin given.⁵²

Insulin probably causes the increased gastric acidity by means of a hypoglycæmia⁷⁴ and not because of the protein present in the preparation. It will not, however, cause increased gastric secretion in a condition of true achylia gastrica and it has been recommended⁸⁴ as a means of differentiating this condition from simple anacidity, just as histamine is now commonly used. In normal individuals, six to eight units of insulin will cause an increase in gastric acidity reaching its maximum in seventy-five to ninety minutes.

Such a powerful substance as insulin is not without its dangers and its untoward effects. Though rare, death apparently attributable solely to the effect of the insulin has been reported. Certainly the most frequent reaction noted, and probably the most serious, is that of hypoglycæmia. Hypoglycæmic reactions occur frequently in the treatment of ordinary diabetes, particularly in children. Often it is mild, is quickly recognized and easily combated by the ingestion of orange juice or some other form of glucose. It is important to differentiate between the hypoglycæmic state and one of diabetic coma, something which at times is not easy. The treatment, obviously is diametrically opposite in the two states. The clinical picture of the two may be somewhat similar, though differentiation is usually possible. The history usually permits of ready distinction; urinalysis or blood-sugar determination will permit of differentiation if there be any question. Several minor differential points also have been noted. In coma, as we have seen, a leucocytosis is usually present; in insulin shock there is frequently a low white count, though Stockinger and Kober claim that insulin may produce a

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leucocytosis.¹¹⁶ A helpful differential point not commonly known is that in insulin shock (hypoglycæmia) a Babinski plantar reflex is usually elicitable.^{3, 10}

Glucose is specific in counteracting the insulin reaction, particularly if given by vein; adrenalin, probably through increasing hepatic glycogenolysis, will throw more endogenous glucose into the blood-stream to buffer the insulin, and has often proven a life-saving procedure; however, continuous adrenalin administration may interfere with proper glucose combustion.²² Caffeine has been claimed by Popper and Jahoda⁹⁷ to have a specific counter-acting effect in insulin poisoning. Incidentally, these authors believe that the reaction seen in insulin intoxication is not solely due to variations in the blood-sugar content. Imerman⁵¹ has used glucose intracardially in grave forms of insulin reaction, with success.

A great deal has been written regarding the relationship between insulin and the heart and circulation in general.^{26, 43, 73, 85, 86, 122} Many have noted deleterious circulatory effects from excessive insulin dosage, but in all probability any untoward effects have been the result of hypoglycæmia, which will undoubtedly embarrass an already diseased heart. However, Parsonnet and Hyman⁹⁸ report seven cases in which insulin precipitated a severe anginal attack, one of them ending fatally, and yet in none of which was there a demonstrable hypoglycæmia present. If careful insulin dosage is used, there should be no fear of harmful circulatory developments.

A rather unusual condition which is sometimes seen, is that of an individual refractory or resistant to insulin.^{6, 35, 48, 61, 65} Schmidt,¹⁰⁸ we have seen, believes that these cases result from inactivation of the insulin by the tissues at the site of injection. Though such an insulin-refractory case is seen at times in an unquestioned case of diabetes mellitus, many authors believe that such a case is either an example of renal diabetes or that it is some new form of diabetes, non-pancreatic in origin, the exact nature of which has not been determined.²⁷ Such an extra-insular condition has been reported following epidemic encephalitis,⁴⁴ but apparently a non-pancreatic form of diabetes mellitus exists for which no etiological factor can be found. Zeckwer, of the University of Pennsylvania, has reported some interesting observations and experiments in rabbits which indicate that insulin resistance may be the result of abnormal action of the sympathetic system, possibly through the intermediation of the thyroid. The thyroid, adrenal and pituitary glands are generally accepted as being antagonistic to insulin in their action.

A more frequent, and sometimes more alarming condition, is that of hypersusceptibility to insulin in which, following administration of this hormone, allergic symptoms develop.^{40, 53, 101, 118, 130} Williams¹³⁰ differentiates the hyperinsulinism reaction from allergic reaction; the allergic may be either local or systemic, and apparently is due to the protein content of the preparation. Herold¹⁴⁶ has pointed out how severe these general reactions may be, and that it is sometimes necessary to change the insulin preparation in order to obtain one to which the patient is not sensitized.

Numerous and sundry other untoward effects of insulin have been reported such as hæmaturia,⁶⁶ insulin lipodystrophy⁹ (which is a localized atrophy of the subcutaneous tissues at the site of injection), retinal detachment,⁷⁸ anuria,¹²⁶ etc., *ad infinitum*. In many instances it is more than questionable as to whether or not some of the untoward results that have been noted after insulin therapy are not entirely coincidental.

Insulin does have an effect on water metabolism, one of dehydration. Therefore, it is reasonable to suppose that it may have undesirable effects if used promiscuously in post-operative cases, which are notoriously dehydrated.¹

No discussion of the relationships between insulin and surgery would be complete without mention of the clinical condition of spontaneous pancreatogenic hypoglycaemia, which has been variously called "hyperinsulinism," "dysinsulinism," "insulinosis" and "dysinsulinosis." Gammon and Tenery³⁶ have presented an interesting discussion of spontaneous hyperglycaemia, and have attempted an etiological classification. It is largely those cases resulting from abnormal pancreatic activity which have, thus far, been of any particular surgical interest.

Hyperinsulinism was first reported clinically in 1924, by Seale Harris.⁴¹ Such overproduction of insulin may result either from hypertrophy or hyperfunction of the islets, or from a benign or malignant tumor of them. Clinically, hyperinsulinism manifests itself in a number of ways, usually resembling insulin shock: weakness, fatigue, nervousness, tremor, hunger, visual or gastro-intestinal disturbances or epileptoid phenomena are the symptoms usually present.

The surgical importance of this syndrome is that a number of cases have been completely cured, either by a partial pancreatectomy, as first performed by the Finneys,²⁸ or by the surgical removal of a pancreatic adenoma^{1, 13, 50, 131} and because the symptoms of hyperinsulinism have been noted in carcinoma of the pancreas^{120, 129} and in carcinoma of the liver^{24, 89} as well as in simple hypertrophy of the islands of Langerhans.⁹⁶ There is every reason to suppose that further clinical and laboratory observations will differentiate an ever-increasing number of conditions, which are at present obscure in nature, and prove them to be due to dysfunction of the insulin-producing mechanism, and which may be amenable to surgical therapy.

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ON THE MORTALITY RESULTING FROM SURGICAL TREATMENT OF CHRONIC GALL-BLADDER DISEASE IN DIABETES MELLITUS

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IT is generally recognized that disease of the gall-bladder is very common amongst diabetics. Autopsy records indicate incidences of 10 per cent. or more among non-diabetics, but high values such as have been found in diabetes have never been recorded. The incidence among adults in our clinic for diabetes is about 25 per cent. This differs very little from the experience of other large clinics. With the introduction of newer and more exact methods of clinical examination (X-ray visualization of the gall-bladder with the aid of dye, etc.) the recognized incidence of gall-bladder disease in general is changing (increasing), but the difference between diabetic and non-diabetic individuals is still marked.

When diabetes and disease of the gall-bladder are found in the same individual, the consensus of opinion is that the relationship, at least in the majority of cases, is causal and not accidental. This view is based upon a variety of data, namely: (a) the above-mentioned difference in incidence, (b) differences between average ages at the onset of the two diseases, (c) clinical studies, (d) metabolic findings, and (e) statistical analyses. The literature on this subject is too well known to require reference to it in detail.

With this combination of conditions, the diabetes is generally attributed to pancreatitis caused by the biliary infection. It is regarded as a true pancreatic diabetes and somewhat analogous to that produced experimentally in partially depancreatized dogs.

Because of the above views, surgical treatment of chronic infections of the gall-bladder is now recommended not only in diabetes to control the disease when active, but also in potential diabetes to prevent its development. Results of such treatment are encouraging; in diabetes, in the majority of cases, carbohydrate tolerance is improved; in non-insulin cases the diets may be made much more attractive and in insulin-treated subjects the amount of this drug may not only be reduced, but its use may, at times, be discontinued entirely. A recent report from this hospital clearly indicates improvement of carbohydrate tolerance in "potential" diabetes.¹ (It may here be observed that, in a number of cases, the relationship between gall-bladder disease and diabetes may not be causal but accidental. To this fact is largely attributed the failure at times to observe improvement of carbohydrate tolerance following such operation.)

In spite of the possible satisfactory results from surgical treatment, the

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advice to the patient is by no means a simple matter. For example, a not unimportant consideration is whether the risk from the operation may not be greater than from the diabetes *per se*. Factors which favor operation are not only the probability of preventing progressive diabetes, but the probability of improving the existing condition. Aside from diabetes and apropos of the gall-bladder *per se*, there is the elimination of a "focal infection" with its possible sequelæ.

Opposed to operation there is, firstly, no proof that the diabetes will progress in a given case if the gall-bladder is left untreated. Secondly, as stated above, though in the majority of cases the relationship between the two conditions may be causal, it might, in a given case, be accidental, and we have no accurate means of differentiating between the two types. Should the relationship be accidental, there is, obviously, no hope of improvement with respect to the diabetes, other than that which might result from the removal of a focus of infection. There is also the important fact that, compared with the other forms of the disease, diabetes resulting from disease of the gall-bladder tends to be mild. Last, but not least, there is the risk of operation. The major nature and the possible sequelæ of this surgical procedure are too well known to require further comment. Possible complications are failure of the wound to heal and the fact that either the anæsthetic or the operative manipulation may lower carbohydrate tolerance of the individual beyond control; the diabetes may become worse instead of better. From experience with hundreds of operations upon diabetics, the latter two complications are admittedly very uncommon with present-day methods of pre-operative and post-operative care. The fact, however, remains that, in spite of all presently available procedures they can and do occur.

This communication is concerned with mortality data only and is based upon the results obtained in fifty cases of diabetes complicated by chronic infection of the gall-bladder. In view of the clinical condition (absence of pain, fever, jaundice, *etc.*), none of these patients could have been regarded as "acutely ill," at least with respect to the gall-bladder condition. There were either no signs and symptoms or, at most, mild and indefinite digestive disturbances. Diagnosis in a number of cases depended largely upon laboratory data. (Blood-sugar time curves, visualization of the gall-bladder with X-rays alone or with the aid of phenoltetraiodophthalein, *etc.*) Exclusion of "acutely ill" cases was important since the purpose of this investigation was to determine whether one is justified in exposing diabetics to surgical treatment for the relief of gall-bladder disease, when not acutely ill. "Acutely ill" cases further complicate the picture because of the many factors which have to be considered, some of which are difficult to recognize, and among those recognizable, many are uncontrollable. In a few cases the diabetes was very mild; the disease could properly be classified as "potential." The group of cases thus afforded variety with respect to severity of the diabetes. The following data indicate that the patients were exposed to a variety of other conditions, also important from the practical point of view.

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The operations were performed by ten surgeons. This variety, therefore, tends to eliminate the personal equation in the interpretation of operative mortality—a not unimportant consideration if the conclusions drawn are to be of practical and general value.

In the study of the results, consideration was given to age, sex, duration of operation, duration of anaesthesia and post-operative course. For comparative purposes, the last two hundred non-diabetics who suffered from chronic infection of the gall-bladder and who were operated upon were collected from the records of this hospital. Among them, twenty-one were found to have been "acutely ill." These, obviously, had to be excluded, in order that the data might be comparable. The combined data are briefly summarized in the following table:

	GROUP			
	Diabetic		Control (non-diabetic)	
Number of cases.....	50		179	
Average age.....	51.8		47.2	
	No.	Per cent.	No.	Per cent.
Sex: Male	9	18	36	20.1
Female	41	82	143	77.9
Anæsthetic: Ether	40	80	136	76
N ₂ O	10	20	43	24
Average duration of operation..	99.5 minutes		90.5 minutes	
Average post-operative stay in hospital.....	28.2 days		26.3 days	
	No.	Per cent.	No.	Per cent.
Deaths	2	4	10	5.5

The average age of the diabetics was 51.8 years and that of the control group was 47.2 years. The data of the non-diabetic group suggested relationship between age and mortality. Thus:

Group	Number of cases	Age (years)	Average age (years)	
			Recovered	Died
Whole	200	46.3	45.7	54.5
Acutely ill	21	47.4	46.7	51.0
Note acutely ill	179	47.2	46.5	58.2

It, therefore, appears that the diabetics, because of their ages, were exposed to a greater risk of death than the control group.

The sex incidences were practically the same in both groups. The selection with respect to sex was accidental, but consideration of sex appears to be necessary since the data of the control group tended to suggest relationship between sex and mortality; males appeared to be exposed to a greater risk than females. Thus:

	No.	Deaths	Per cent.
Males	36	3	8.3
Females	143	7	4.9

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There was variety with respect to operation. Thus:

<i>Type of operation</i>	<i>Number of cases</i>
Choledochotomy	3
Cholecystotomy	15
Cholecystectomy with drainage of common bile-duct	15
Cholecystectomy without drainage of common bile-duct	17

In forty of the fifty cases, ether was the anaesthetic used and in ten instances it was nitrous oxide. This agrees very closely with the control group in whom ether was used in 76 per cent. and nitrous oxide in 24 per cent. of the cases.

The duration of operation ranged between 50 and 150 minutes; the average duration was 99.5 minutes. This was slightly longer than the average duration for the control group, which was 90.5 minutes. The control data suggested relationship between duration of operation and mortality. Thus:

<i>Group</i>	<i>Average duration of operation</i>
Recovered	90.3 minutes
Died	113.0 minutes

It therefore appears that the diabetics, with respect to duration of operation, were exposed to a greater risk of death.

The post-operative course (healing of wounds, convalescence, *etc.*), was practically the same in the diabetic and control group. The average post-operative stay in the hospital was 28.2 days in the diabetic, and 26.3 days in the control group. This difference is attributed to the prolonged drainage of the common bile-duct which was deliberately carried out in fifteen cases. That the drainage was the chief factor to account for this prolonged period is also suggested from experiences with the control group. Thus:

Total group	26.3 days
Without drainage	20.3 days
With drainage	27.4 days

Among these fifty cases of diabetes there were two deaths. The details about causes of these deaths are irrelevant for present purposes. From the practical point of view, it may also be observed that relatives receive very little consolation when informed about the cause of death; it is the death alone which matters.

Deductions from the above statistics are difficult for a number of reasons. Firstly, the number of cases, especially among the diabetics, is too few to attach significance to percentages. (The mortality in this group was, obviously, 4 per cent., and, incidentally, less than in the control group.) In view, therefore, of the smallness of the group, it was considered advisable to express the diabetic mortality in terms of the ratio actual to expected deaths. When consideration was given to (a) the ages of the individuals at the time of operation, (b) the number of deaths, and (c) the number of individuals who not only survived operation but are still alive, the actual to expected death ratio was found to be 124 per cent. of the normal. This, it

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may be observed, approximates fairly closely the actual to expected death ratios of our diabetic clinic as a whole, since the use of insulin. Thus:

Year	Ratio of actual to expected deaths \times 100
1923	280
1924	243
1925	200
1926	109
1927	107
1928	124
1929	112
1930	118

In other words, exposure of fifty diabetics suffering from *chronic* infection of the gall-bladder to operation for relief of the latter condition had an inappreciable effect upon mortality. Operation appeared to be justified by the good results obtained among the surviving individuals; all of the forty-eight patients are alive and the average period which has elapsed since operation is twenty-eight months.

Expressed in terms of insurability of the individual, life assurance companies would apply to a group of people with the aforementioned ratio of actual to expected deaths a rating of about three years. In other words, if life assurance companies could be assured of such a ratio among diabetics who are suffering from gall-bladder disease in the country as a whole, such individuals would be accepted as policy-holders and the premiums would be increased only to the extent of making the individual pay an amount as though he were three years older than his actual age. Of course, life assurance companies, as a rule, will not accept diabetics, with or without gall-bladder disease, for the simple and sufficient reason that the ratios of actual to expected deaths, in countries as a whole, are much larger than those found in hospital clinics.

In conclusion, it must again be observed that one cannot be dogmatic, in view of the smallness of the group. The purpose of this investigation was to determine whether one is justified in exposing diabetics who also have gall-bladder disease to operation for the relief of the latter condition, when not "acutely ill." The data suggest that with proper selection of cases and proper pre-operative and post-operative care of the diabetes, recommendation of surgical treatment is justified.

The writer is indebted to Dr. A. T. Bazin for his critical analysis of the surgical aspects of this investigation, and to Dr. A. T. Fowler for his collection of the data.

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FAT EMBOLISM

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CAREFUL examination of autopsy material will frequently disclose the presence of fat within the capillaries of the lungs, kidneys, brain and other organs. In most instances, the fat globules are not sufficiently numerous to have produced clinical symptoms, but in some cases, especially traumatic ones, fat may exist in such quantities in the vascular system as to give definite indications as to the cause of death.

Warthin,¹ in his excellent monograph on this subject, called attention to the inadequacy of American literature on the subject as compared to European literature. He said, "the time has come that more attention should be paid to this sadly neglected branch of surgery and that the occurrence of fatty embolism after an injury to the bones be at least regarded as a possibility and that preventive means be instituted or therapeutic efforts be made whenever there is a suspicion of its occurrence." Indeed, at the present time, the charge may be made that American clinicians and pathologists in general give too little attention to so important a condition.

The author, to stimulate interest in the study of fatty embolism, offers a brief review of the subject together with the reports of two typical cases. For a history of fat embolism, reference is given to Warthin's monograph.

Endogenous fat embolism is almost always the result of physical injury to one or another of the fat depots of the body. Injury, especially fractures of the long bones, is by far the most common cause. There is no definite parallelism between the extent of trauma and the amount of fat liberated into the circulation, since fatalities are sometimes seen as a result of fracture of a single bone, while in other instances fractures of a number of long bones have not produced symptoms of fat embolism.

According to Conner² the character of the marrow fat is one of the determining factors in the production of fat embolism, for he points out that fat in older persons is more liquid, since it contains more olein, while in children, according to both Zwerg³ and Timmer,⁴ it is more cellular and contains more palmitin. This may explain why the condition is more commonly observed in persons past the age of fifty. That the condition may be seen in younger persons is shown by Utgenannt⁵ who reported a case in a child eight years of age, by Work⁶ who reported a case in a person eighteen years old, by Burns⁷ who reported a case in a person twenty-two years old, and by Ryerson⁸ who reported a case in an infant eight months old.

Orthopædic operative procedures are a fruitful cause of fat embolism. There is a long list of such references in the literature. Warthin gives

twenty-two references, while Ryerson and Timmer, to mention only a few, have also stressed this fact.

Concussion of atrophied bones has been the cause of severe fat embolism, as is illustrated by cases reported by Fields,⁹ Beitzke¹⁰ and others. Timmer states that atrophied bones at any age may contain much fat and in the very young may be the origin of the fat in fat embolism. Bissell¹¹ and Sutton¹² have reported cases following operations on the soft parts, such as radical breast amputation, umbilical hernioplasty and laminectomy. Many other references could be cited if space permitted.

Milaslavich¹³ thinks that contusions may play an important part in the

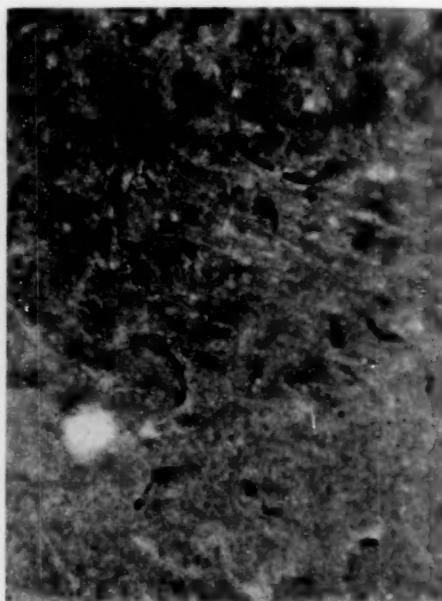
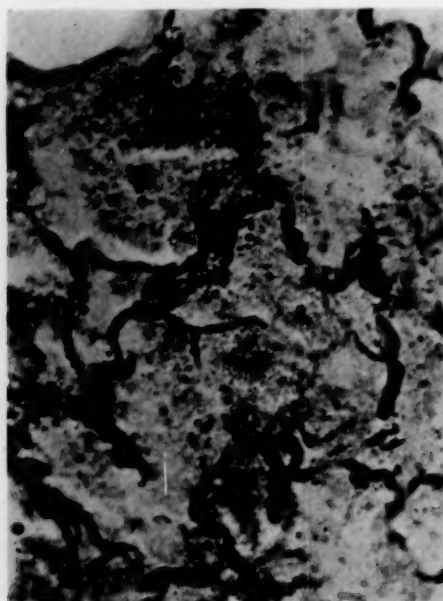


FIG. 1.—Fat emboli in lungs. Herxheimer's method.

FIG. 2.—Fat emboli in brain. Herxheimer's method.

production of this type of fat embolism. This is not new, since Warthin stressed this possibility in 1913.

Fat embolism of a minor type has been reported in such conditions as pancreatitis, chronic nephritis, diabetes mellitus, chronic tuberculosis, acute and chronic alcoholism. According to Warthin and other workers, fat embolism is seldom, if ever, fatal in these conditions, unless trauma is present.

Burns and Bromberg¹⁴ and Brittingham,¹⁵ in reporting cases of death following therapeutic use of salvarsan and neo-salvarsan, suggest that in some cases, at least, the punctate hæmorrhages in the brain may be the result of the occlusion of the small vessels by fat.

Fat enters the vascular system at the site of injury where vessels are torn. The bones are ideal locations, for marrow of the long bone of the adult is rich in fat and has many vessels. It is possible that by suction fat may be

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drawn into the veins, or, on account of the hæmorrhage into the marrow cavity, the fat may be forced into the vessels. Fat, having entered a vein, is carried to the right heart, then to the lung, through which it may filter and pass to the left heart, to be distributed throughout the greater circulation. Instead of passing through the lung, Fromberg¹⁶ suggests that it passes through an open foramen ovale in most cases. That this is not always true is well shown by one case herewith reported.

As to the distribution of fat, much will depend on the myocardium and the capillaries of the lungs. Warthin noted many cases in which there was marked dilatation of the right heart. If the heart is powerful enough to

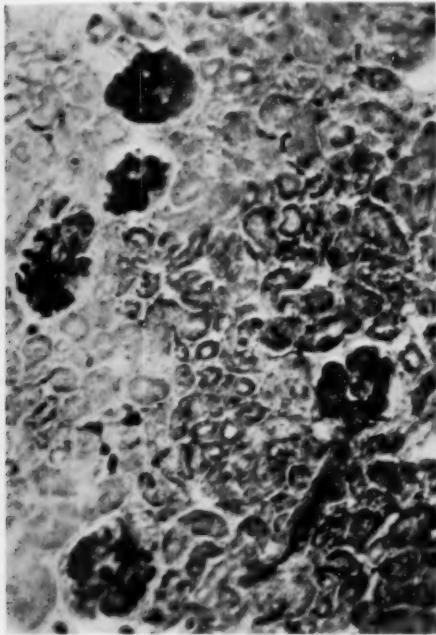


FIG. 3.—Fat emboli in the kidney. Herxheimer's method.

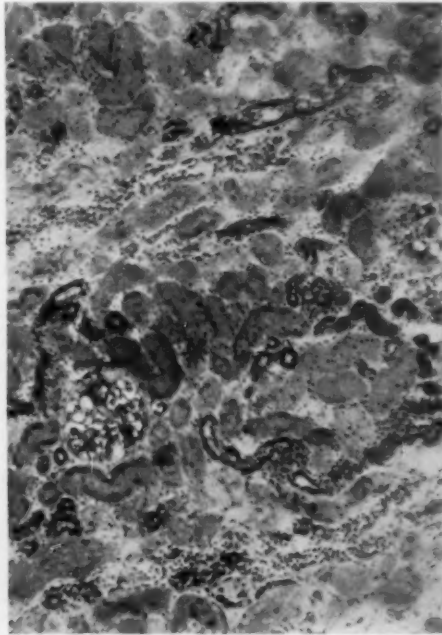


FIG. 4.—Kidney showing tubular degeneration. Hæmatoxylin and eosin.

push the fat through, death may not take place; on the other hand, the heart may be normal and the obstruction too great for it to overcome. It is also possible that changes in the pulmonary capillaries incident to age or disease of the lung may offer increased resistance.

There are two important factors in fat embolism; namely, the quantity of fat and the duration of the discharge of fat into the vascular system. It is easy to understand how these factors may vary and the outcome be changed. If the quantity is large enough it may not pass through the right heart and death may be instantaneous; more finely divided particles may be distributed through the lungs over a short period of time and death take place very quickly from failure of the right heart or from pulmonary œdema.

If the quantity is not too large and the right heart does not fail, much

fat may pass through the lungs and be distributed to all parts of the body. This fat, in the greater circulation, can be found in any tissue, but of course it causes symptoms from its effect on such vital organs as the heart, the brain, kidneys and glands of internal secretion.

In fat embolism there may develop in the lungs, lobular emphysema, small hæmorrhagic areas and pulmonary œdema. According to Lehmann and McNattin¹⁷ slow distribution in experimental animals will cause small collections of wandering cells, fibrosis, endothelial proliferations and sometimes miliary collections of polymorphonuclear leucocytes. In the heart there are apt to be areas of fatty degeneration in the region of fat emboli. In the brain one finds many hæmorrhages in the sub-cortical white substances, especially the corpus callosum (Gauss,¹⁸ Melchoir,¹⁹ and Fromberg¹⁶). These hæmorrhages are perivascular and at the point where a globule of fat closes the central vessel. In the kidney the glomeruli are apt to be full of fat and degeneration of the tubular epithelium may be present. According to Paul and Windholz²⁰ there may be evidence of renal disturbances. There may be small hæmorrhages in the skin and in fact in almost any organ in the body. While the above lesions are often definite, yet there are fatal cases of fat embolism with only slight gross changes, so that it is only after properly prepared histological sections are examined that the correct diagnosis can be made.

It is relatively simple to make the diagnosis at post-mortem, but it requires considerable care to determine the significance of the findings. In the laboratories here, blocks are taken from the lung and frozen sections twenty to forty microns in thickness are made and stained by Herxheimer's method for fat. In suspicious cases more than one portion of the lung and also other important organs are examined. Only low-power magnification is required, as the fat is easily seen. Relatively thick sections are made so that the fat may be held in the vessels. Examination at post-mortem should be made for fat embolism in all traumatic cases, especially if there are few or no lesions found in the gross to explain death.

The clinical pathology is quite as definite and should always be borne in mind. Fat may first appear in the sputum and later be found in the urine. Warthin says, "the presence of free fat and fat granule alveolar cells in the sputum is the earliest positive evidence of the condition being detected even before the appearance of free fat in the urine."

Fat embolism is by far the most common type of embolism. Scriba²¹ found it in 52 per cent. of all bodies. Lehmann and McNattin found it in thirty-nine out of fifty cases. In routine autopsies as done in general hospitals the best figures show around 50 per cent. of all cases to have more or less evidence of fat embolism. This, of course, does not mean that 50 per cent. die of fat embolism. Milaslavich found fat embolism in all of twenty-two cases of automobile accidents and concluded that it killed two.

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DIGEST OF ONE HUNDRED CONSECUTIVE AUTOPSIES

<i>Cases in which fat was not found in the pulmonary vessels</i>			
(1) Cases without history or evidence of trauma			33
(2) Cases with history or evidence of trauma:			
Major operations	11		
Minor contusions	2		
Pregnancy with delivery	1		
Old fracture	1		15
			—
Total			48
<i>Cases in which fat was found in the pulmonary vessels</i>			
(1) Cases without history or evidence of trauma:			
Very occasional globule	22		
1 = plus (globules in every 4-6 l.p.f.)	4		
2 = plus (globules in every 2 l.p.f.)	1		
			27
(2) Cases with history or evidence of trauma:			
(a) Very occasional globule			
Major operations	7		
Cerebral hæmorrhage	3		
Pregnancy and delivery	2		
Birth injury	1		
			13
(b) 1-plus (globules in every 4-6 l.p.f.)			
Fracture of pelvic bones	1		
Osteomyelitis, chronic	1		
			2
(c) 2-plus (globules in every 2 l.p.f.)			
Cerebral hæmorrhage	2		
Convulsions	3		
Multiple lacerations and contusions	1		
			6
(d) 3-plus (globules in every l.p.f.)			
Puerperal sepsis	1		
			1
(e) 4-plus (globules in practically every capillary)			
Convulsions after cerebral apoplexy	1		
Alcoholic delirium with restraint	1		
Fracture, contusions and burns	1		
			3
			—
Total			52

In the table there is an outline of 100 consecutive autopsies performed at University Hospital. It will be noted that fifty-two had some fat in the pulmonary vessels. It can be seen at a glance the rôle played by trauma. Among these 100 cases there is no doubt that fat embolism was of a major importance in at least three, only one of which was traumatic at the onset of the fatal illness. In arranging this table a case was classified under trauma if there was any possible reason for so doing. Operations, pregnancy, and cerebral hæmorrhages were all considered as traumatic in this study.

The two cases herewith reported were not in the series of autopsies discussed in the table.

CASE I.—Mrs. B. M., Autopsy 1367, Chart No. 57879, white female, aged fifty-nine years, admitted April 18 in coma and died April 19. On the evening of April 17 the patient fell from a street car in front of her home and had to be carried into the house. The family physician found a fracture of the left hip. She was given morphia and made as comfortable as possible until the next morning. When he returned, finding her stuporous and irrational, he sent her to the hospital at once. On admission the temperature was 99° by axilla, pulse 110, respirations 22. The patient was in coma and had labored respiration, the face was drawn and there was no attempt to move. The pupils were contracted, equal, regular, and reacted to light. The right eye was rotated outward and upward, the fundi were negative. The heart and lungs were negative. The blood pressure 110/68. There was some general resistance over the entire abdomen. The extremities were definitely spastic and there were signs of fracture of the left femur. The leg was supported by pillows and she was given intravenous sugar, salt and stimulants. The temperature gradually rose to 107° by axilla, the pulse to 185, and the respirations to 40. She died about forty hours after the accident. (See temperature chart.)

X-ray Report.—Fracture with displacement, neck of femur, left. No evidence of skull fracture.

Laboratory Findings.—Urine on admission normal. Twelve hours later albumin and sugar were found. The urine was never examined for fat. Blood: red blood-cells, 4,370,000; white blood-cells, 12,500; hæmoglobin, 65 per cent.; polymorphonuclears, 86 per cent. Small lymphocytes, 8 per cent. Large mononuclears, 4 per cent. Spinal fluid, negative. Wassermann, negative. Blood chemistry: non-protein nitrogen, 29. Sugar, 93.

Clinical Diagnosis.—Fracture, neck of femur, left. Concussion of the brain.

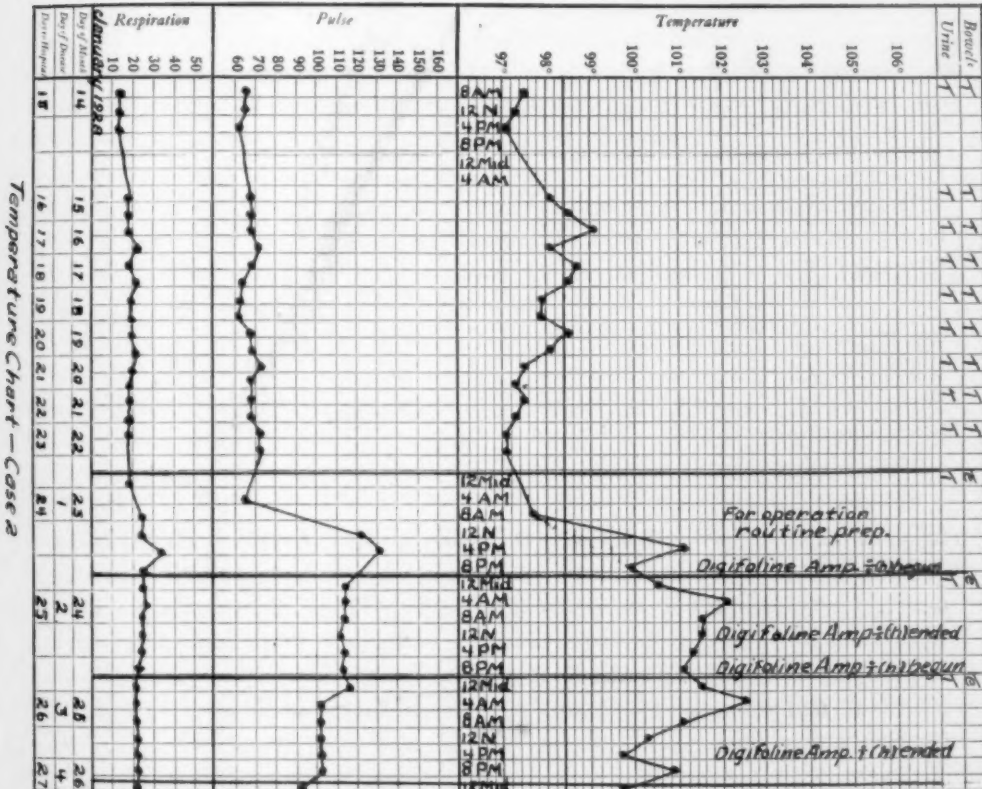
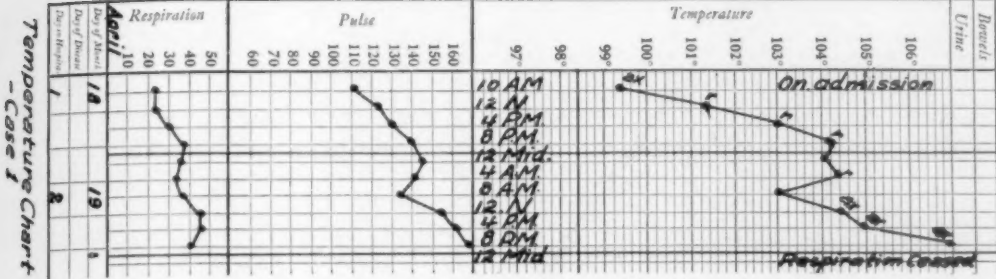
Autopsy performed one hour after death. The only positive findings in the gross were fracture of the left hip, small hæmorrhages in the brain, moderate arteriosclerosis, mild scarring of the kidneys, congestion of the lungs and abdominal viscera, bilateral hydrothorax—right, 300 cubic centimetres, left, 150 cubic centimetres, slight hydro-peritoneum, slight œdema of the ankles. The foramen ovale was anatomically closed.

Frozen section stained by Herxheimer's method for fat showed extensive embolism in the lungs, brain and kidneys. Sections stained by hæmotoxylin and eosin showed many perivascular cerebral hæmorrhages and marked degeneration of the epithelium of the convoluted tubules of the kidney. There was no pneumonia.

The above is a typical case from several points of view. Clinically, a patient in coma too often suggests only diabetes or nephritis. Not once was fat embolism considered, yet under the circumstances it was by far the most likely thing. The autopsy was performed by a man who had done but 30 or 40 post-mortems and did not suspect this condition. As soon as those who had more experience at post-mortems became aware of the case, the question of fat embolism was introduced and its existence proved a few minutes later by simple frozen section.

CASE II.—Chart No. 61170, white male, aged forty-two years. October 8, 1928, the patient sustained a fracture of the shaft of the right femur and the left humerus. These fractures failed to unite after being immobilized. January 23, 1929, an open reduction of the femur was done. When the smooth ends of the ununited fracture were broken into, a large amount of pus-like material (later found to be fat) escaped. Two hours after operation the patient went into profound shock and remained in this condition for forty-eight hours.

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Laboratory Findings.—Urine: The urine frequently showed albumin and casts, and on January 24 and 31, large quantities of fat were present. Blood Chemistry: "Non-protein nitrogen," 30 to 39.9; urea nitrogen, 14 to 18.6; creatinin, 1.5 to 1.7; blood sugar, 111 to 118. Blood Wassermann was positive. This case ultimately recovered and left the hospital. The post-operative shock was considered to be due to fat embolism. (See temperature chart.)

From the pathology of the condition it is clear that almost anything can happen. If the greater circulation contains many globules of fat it is obvious that they may lodge in any organ and thus cause a great variety of symptoms. Clinically, in the main, there are two general types of fat embolism, namely, the one with cardiorespiratory symptoms and the other with cerebral symptoms.

The cardiorespiratory group is apt to present dyspnoea, cough, cyanosis, pulmonary oedema, even pulmonary hæmorrhage, low arterial and high venous pressure, cardiac dilatation, precordial distress, elevation of temperature and Cheyne-Stokes respiration. The cerebral type is apt to present restlessness, headache, delirium, drowsiness, stupor, coma and even convulsions. Many cases present a combination of the above.

In making the diagnosis, clinically, the most important point is to keep fat embolism in mind in every traumatic case where the symptoms are not clearly explained by definite findings. Warthin says, "fat embolism resulting from traumatic lipæmia is an important surgical condition which is not of rare occurrence but is probably at the present time, in the absence of infection, the most frequent cause of death after fractures of the long bone." Fat can easily be demonstrated in the sputum and in the urine and, as has been mentioned, it may be found in the vessels in the fundi of the eyes. If one remembers that fat embolism results from many types of trauma, especially fracture of a long bone, and that it is the extent of the embolism and the condition of the involved organ that determines the symptoms, there will be many more cases diagnosed clinically.

It is obvious that treatment of any condition so often not even considered is apt to be far from satisfactory. Diagnosis is, of course, the first step in rational therapy. All agree that shock and pulmonary oedema may demand immediate treatment, but it has occurred to but a few that a tourniquet properly applied in shock following fracture may be of much or more importance than any other procedure (Caldwell and Huber²²). Some have been so bold as to drain the thoracic duct (Wilms²³). Others have opened simple fractures, and even amputation (Melchoir) has been performed to prevent fat embolism. Such procedures in selected cases may be of value, for one is dealing with a major condition. Infusions have been used (Schanz,²⁴) with some degree of success. Porter²⁵ thinks that there is a critical diastolic blood-pressure level, below which, if the pressure fails, it does not return unaided.

To bring about a return he advocates carbon-dioxide increase in respiratory air, heat, adrenalin, elevation of lower portion of the body, infusion and

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transfusion. It is generally thought that care in handling cases of fracture of long bones will do much to prevent or at least to lessen fat embolism. The Thomas splint probably has done much to reduce fat embolism in those that have to be transported after a fracture of one of the long bones.

This condition is of importance to those interested in medico-legal medicine. In Germany this aspect has received considerable stress, while in this country it is seldom considered. Milaslavich has recently reported a case where the finding of fat embolism in a body recovered from a burning dwelling was admitted as evidence in court and helped to show that the woman's husband murdered her and then burned the house to conceal the crime. There is no doubt that the medico-legal aspect of this malady has by no means been fully developed and will, as time passes, be of more and more interest to the forensic world.

SUMMARY

The clinical and pathological aspects of fat embolism are presented. Two cases are reported, one resulting in death and the other in recovery. A digest of 100 consecutive autopsies as regards this condition is presented. It is felt that fat embolism should be considered in any case where there are grave or unusual symptoms following trauma, whether the trauma be fracture, concussion, intravenous therapy, delivery or operation.

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ONE THOUSAND SPINAL ANÆSTHESIAS

WITH SPECIAL REFERENCE TO COMPLICATIONS AND MORTALITY*

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ONE who writes on spinal anæsthesia and who studies the literature is impressed by the fact that the last word has not been said on the subject. Some believe in it absolutely, others cry out anathemas and declare they would never submit their own bodies to the needle. Much has been written and many thousands of anæsthesias have been given, yet when some men publicly state, as one has only recently: "The more you use it the less confidence you have in it," to what can we pin our faith? The work of Labat, Babcock, Evans, Pitkin, Koster, Sise and others has been fully studied by the writer and has been most helpful in solving many of our problems. Just recently has appeared the report by Muller¹ and Overholt, of the University of Pennsylvania Hospital, based upon over 500 spinal anæsthesias, in which many of their observations very nearly parallel those reported in the present paper.

In this brief presentation I embody some results and observations in our first thousand operations under spinal anæsthesias covering a period of nearly two years. These are given under the following heads: (1) Classification of cases; (2) type and dosage of the anæsthetic agent; (3) difficulties in administration, including either complete or partial failure of the anæsthesia; (4) complications; and (5) mortality.

(1) *Class of Cases.* These, for convenience, have been divided as follows, irrespective of age, which varied from eighteen to eighty years.

(a) Operations on lower extremities, including bone grafts, amputations, insertion of tongs in fractured femurs, and various orthopædic operations, *etc.*, 121 anæsthesias.

(b) Hæmorrhoids, perineal, bladder and hernia operations, *etc.*, 386 anæsthesias.

(c) Pelvic and lower abdominal operations, kidney operations, Cæsarean sections, rectal resections, *etc.*, 323 anæsthesias.

(d) Upper abdominal operations, gastric and gall-bladder surgery, surgery of the small intestine, splenic surgery, *etc.*, 170 anæsthesias. Total, 1,000 cases.

It should be noted that we did not employ spinal anæsthesia for thoracic surgery, surgery of the breast, thyroid, *etc.*, in spite of Koster's brilliant success. We still believe nitrous oxide or local anæsthesia combined with sodium amytal is safer in the long run for the average surgeon in this class of cases.

* Read before the Association of Military Surgeons of the United States, November 30, 1931.

(2) *The Anæsthetic.* We used only three preparations, spinocaine, neocaine and novocaine. While no hard-and-fast dose was adhered to, we took as a minimum two cubic centimetres of spinocaine and as a maximum four cubic centimetres, expanded to a maximum of eight cubic centimetres with spinal fluid. As a general rule, we selected two cubic centimetres for lower extremities, hæmorrhoids and perineal operations, and from 3.25 to four cubic centimetres for other operations. In spite of using four cubic centimetres a great many times we were never able to do satisfactory routine cholecystectomies with spinocaine, although we could usually do gastric surgery without trouble and really preferred spinocaine because it seemed to depress the patients less and the anæsthesia lasted longer. For cholecystectomies during the last year we have injected neocaine and our troubles have practically vanished. At first the dose injected was 240 milligrams, but subsequently this was reduced to 200 milligrams and this is now the average dose, withdrawing eight cubic centimetres of spinal fluid. This dose is said by some writers to be high, but what is high for some patients is seemingly not high for others. Why some patients will maintain a blood-pressure of 140 under 240 milligrams of neocaine and others will sink to zero with 200 milligrams or less is difficult to explain. A cholecystectomy usually requires from forty-five minutes to an hour or more and we have found 200 milligrams of neocaine in eight cubic centimetres of spinal fluid maintains perfect anæsthesia for one hour. For using neocaine or novocaine, a large ten-cubic centimetre Pitkin syringe is perfection itself. In a few cases where we had a long operation, such as a gastroenterostomy, cholecystectomy and appendectomy in a single patient, or a tedious gastrectomy, or where relaxation was insufficient, we used ether for a short time, replacing this with nitrous oxide as we were finishing the operation.

(3) *Difficulties in Administration.* These were not inconsiderable. The average writer who gives us the benefit of his experience in spinal anæsthesia is slow to admit that he has any difficulties, but we are still having them after considerably more than 1,000 anæsthesias. With neocaine or novocaine there is usually no trouble if the spinal fluid runs at all. With spinocaine, to get proper mixing of the spinal fluid with the anæsthetic is sometimes not possible. In some stiff spines with chronic spondylitis it is practically impossible to use spinal anæsthesia. In an occasional case in which spinocaine was used and where there was no failure in technic, no anæsthesia was noted and there was no relaxation whatever in thirty minutes. We have seen an occasional patient so nervous that a general anæsthetic seemed almost necessary in order to give a spinal. On the whole I think it can be said that the use of procaine crystals dissolved in spinal fluid is easier and certainly much more sure in action than spinocaine—in fact, we never had a real failure with neocaine. Spinocaine, however, to most observers will *seem* safer at least, because with this agent we do not experience the complete drop in blood-pressure and apparent prostration, and, of course, one is never hurried with spinocaine because the anæsthesia lasts usually two hours or more. I should say we

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have had 100 per cent. satisfactory anæsthesias in perineal and orthopædic work and perhaps slightly over 90 per cent. in lower abdominal work, using spinocaine. To put it succinctly, spinocaine would be the perfect spinal anæsthetic if it were always sure of producing complete anæsthesia, and neocaine would be the perfect anæsthetic if the anæsthesia would last twice as long.

(4) *Complications.* Under complications I have listed all symptoms and physical signs which seemed to be at all important or to cause anxiety, whether immediate or remote, and whether or not we were sure they were caused by the spinal anæsthesia. These were as follow, more or less in order of frequency: (a) Nausea, vomiting; (b) collapse, weak pulse, no blood-pressure, loss of voice, extreme pallor; (c) headache, sciatica; (d) respiratory failure; (e) lung collapse.

(a) Nausea either alone or occasionally associated with vomiting occurred in at least 15 per cent. of the cases, more rather than less. It is quite possible had we routinely used large doses of sodium amytal pre-operatively with pantapton instead of morphine the number would have been appreciably smaller, but I doubt it.

It was seldom troublesome enough to delay the progress of the operation but there were a number of cases in the series in which nausea and straining were prolonged. If this did not yield to ice on the head, aromatic ammonia fumes and oxygen were administered, and, if these failed, ether was given. It is freely admitted that where nausea and straining persists, even if ever so little, this may seriously interfere with some tedious and delicate abdominal operations, such as lumbar sympathectomy, for instance, but it is seldom that it really does. If vomiting persisted after return from the operating room, it usually yielded to mild measures in a few hours. It was never a feature after twenty-four hours.

(b) In a very small number of cases, not over half a dozen, in which elective operations were done, there were observed some alarming symptoms. One of these was a cholecystectomy in which 200 milligrams of neocaine were used, another was an attempted cholecystectomy in which four cubic centimetres of spinocaine were used and this had to be reinforced with ether before the completion of the operation. The others were abdominal operations with four cubic centimetres of spinocaine. In only two was there complete loss of voice, but in several there was noted a "crowing" voice. Every case responded immediately to intravenous salt solution with inhalations of CO₂. The alarming symptoms came on generally about ten or fifteen minutes after the anæsthesia was begun.

(c) Headache was never a prominent symptom. We had only one very severe headache lasting a week. The others were all relatively mild and few in number, lasting usually five or six days. Sciatic pain occurred only occasionally, but one case being of any severity. This one case, however, took six months to recover.

(d) Respiratory failure occurred in but one instance, although there were

a number of cases in which the respiration dropped to 5 or 6. This was a nephrectomy in which four cubic centimetres of spinocaine were used in a frail woman of fifty weighing but 100 pounds. It was noted at the time she was moved from her side to her back at the conclusion of the operation. She required artificial respiration and oxygen but the symptoms disappeared in two hours, only to reappear at the end of twenty-four hours and again in three days. This patient died on the fourth day. No autopsy was obtained, in spite of urgent requests.

(e) Lung collapse seems to occur quite frequently after spinal anaesthetics, practically always after abdominal operations. Whether it is more frequent than after inhalation anaesthetics I cannot say, but I am beginning to believe it is. At all events, in many cases in from twenty-four to forty-eight hours after a simple appendectomy, for instance, the temperature rises to 102° or 103° with respiratory distress and an X-ray shows the collapsed lung with the heart displaced. I am sorry I cannot quote statistics, for we missed many early cases in the series and thought they were aborted pneumonias, pleurisies, *etc.*, because the patients got well so promptly. Spinal anaesthesia is no protection against lung collapse but lung collapse seems almost never fatal no matter how ill the patient seems to be. Since August of this year when we began to X-ray all suspicious cases we have had six lung collapses after spinal anaesthetics, a percentage of 4.3, considering solely the cases of abdominal surgery, since the lung collapses occurred in no other class of cases. We have also had collapses after general anaesthetics. No case of lung collapse, or, indeed, of any grave complication, occurred in the 300 or more anaesthetics in which only two cubic centimetres of spinocaine were used. We have only recently used CO_2 inhalation as a preventive of atelectasis as advocated by Graham, and cannot give an opinion as to its value except as a respiratory stimulant where the respirations fall too low for safety. Apparently the dose of spinal anaesthetic may have some bearing on lung collapse but there are too many other factors present for us to be sure. These factors are, of course, the type of operation, the use of morphine, scopolamine and sodium amytal and so on.

(5) In considering the mortality I have tried to be honest, for I feel that the continued use of spinal anaesthesia or its discontinuance for general use will depend to a large extent on the honesty and freedom from bias of the reports. At our hospital we have endeavored to surround the administration of the anaesthetic with due precautions. If we err in technic, in the selection of cases for spinal anaesthesia and in dosage, we want to know it. In discussing mortality I include all deaths during the two years covering the report occurring within three days of the administration of a spinal anaesthetic, even though the anaesthetic is supposed to be eliminated in from six to eight hours. At the outset we may say we have had no death on the table or within three hours of the administration of the anaesthetic, and we do not believe we have had any case in which we can be certain that spinal anaesthesia caused death or even contributed to a fatal issue in the entire series. The list of deaths with details is placed at the end of the report, there having been a total of

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fourteen during the period of two years covered by it. In studying these deaths I think any fair-minded critic would certainly dismiss all but Cases III, V, IX, and X as having been not influenced in any way to a fatal issue by the spinal anæsthesia. In my own opinion, Cases III and V and possibly IX (all of them are women) are the only ones in the series where we could even assume for the sake of argument that the type of anæsthesia had anything to do with the result. Of course, if one gives a spinal anæsthetic and the patient promptly dies with certain symptoms, we can say *post hoc propter hoc*, and lay the blame upon the anæsthetic, but we have had no such case. We all know that in a few hours after a spinal anæsthesia, sensation returns and the effects of the anæsthetic have apparently disappeared. What, then, is our time limit in placing responsibility for any untoward event that may occur? I make no attempt to answer this.

In examining these three deaths more in detail, Case III was a young woman, a blonde so pronounced as to look a little like an albino. She had had two children and looked and seemed in good general health. She had been under observation on the Medical Service of the hospital for some time for survey and was regarded as a good risk. Her death was fairly sudden as she showed none of the alarming symptoms on the table and left the operating room smiling and talking to her husband and with a normal pulse and respiration. In the first twenty-four hours we were not even aware of the fact that her convalescence was not proceeding normally. Her death was preceded by increased respiratory rate, staring eyes, rapid pulse and loss of consciousness. There was slight dilatation of the stomach but no vomiting nor rise of temperature. I cannot believe the anæsthesia influenced her death but it was difficult to see why she died. After her death it was discovered that she had been exceedingly fearful of the operation. How much fright contributed to her death no one knows. Case V was the only one in the series where I felt that we had a suspicion that spinal anæsthesia had any part in the result. This patient was a very frail woman, manifestly and admittedly a poor surgical risk. She received a full four cubic centimetres of spinocaine but beyond a pronounced drop in blood-pressure and loss of voice she showed no symptoms causing apprehension during the operation in which the kidney was removed. As soon as she was turned from her side to her back, respiration practically ceased, although the patient was perfectly conscious. She kept whispering that she could no longer breathe. She responded to artificial respiration, oxygen and CO₂ but was kept on the table for an hour, after which she was sent to the ward. She had another similar attack in less than twenty-four hours but again recovered and seemed to be doing well for a while but at the end of the third day she suffered a third seizure with respiratory failure and died in a few hours. Had her death occurred in the first twenty-four hours, as it very nearly did, we would unquestionably have laid it at the door of spinal anæsthesia, but, occurring as it did, after seventy-two hours, we could not be sure. The blood chemistry was practically normal and since an autopsy was refused her death was recorded as due to cerebral embolism, which seemed as reasonable as to charge it to the anaesthetic. Case IX was an elective operation in a woman who had been operated on before under a general anæsthetic but who had had such a bad recovery following ether that we advocated spinal. She was very talkative, extremely apprehensive and was exactly the type which gets you into trouble. She had a comparatively simple operation entirely in the pelvis and did well on the table. Almost immediately, however, she began to show danger signals, rapid pulse, restlessness and semi-delirium. An ileus developed rapidly. An ileostomy was done under local anæsthesia but the patient went from bad to worse and died in sixty hours. Autopsy diagnosis was paralytic ileus. Case X needs only scant mention. This patient died in forty-eight hours after a cholecystectomy with the familiar complication, high

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temperature, rapid death. For many years I have been accustomed to have an occasional patient who unexpectedly developed a temperature of 105° to 107° about two days after a cholecystectomy and this seemed to be one of these cases. Nothing about the case indicated that the anæsthetic played any part in it.

I have purposely laid all the information in these deaths on the table for all those interested to study, not that I desire to emphasize them but because I do not wish to present a paper on spinal anæsthesia and in conclusion say with finality so that none can say me nay: "There were no deaths from the anæsthetic." The reader is therefore at liberty to draw his own conclusions as to the danger or safety of spinal anæsthesia in these 1,000 cases.

A celebrated surgeon once said, you may remember, that "With statistics you can prove anything, even the truth." Therefore, in closing, I shall quote a few statistics without trying to draw conclusions. In two years we have had no mortality in Cæsarean section, in ruptured gastric and duodenal ulcer or in gastric and intestinal resections where we used spinal anæsthesia. In the last year we did 246 consecutive appendectomies under spinal anæsthesia before we had a death and we also did thirty operations on the gall-bladder and bile-ducts, practically all cholecystectomies with but two deaths, both forty-eight hours post-operative, and one of these was complicated with multiple liver abscess. When I examine our mortality record in the years prior to 1930 and 1931, while of course the surgery done does not exactly parallel these two years, I am nevertheless convinced, without trying to be persuaded, that we could hardly match our record with any other anæsthetic. We must remember, also, that no mention has been made of many cases such as multiple intestinal resections for gunshot wounds of the intestine, appendectomies in the presence of pneumonias, and so on, where death seemed almost certain had not spinal anæsthesia been available.

Finally, I wish to say that I think our best defense of spinal anæsthesia, if it really needs any defense, is that we are continuing to use it. Certainly it is a boon for the ordinary surgeon because it makes him at once a far more skilful operator on account of the quiet abdomen in which he works. For fractures of the lower extremities it is a Godsend, and a medical student can put up a femur perfectly well under spinal anæsthesia. An amputation of the thigh under two cubic centimetres of spinocaine seems like a minor operation, almost, and we have done five consecutive thigh amputations with no mortality under spinal anæsthesia. In the military service it should be used universally both in peace and war for practically all surgery of the lower extremities where a small dose is sufficient. However, it is a sharp-edged tool and a jealous mistress and in the higher doses and in upper abdominal surgery it should be employed only by those skilled and experienced in its use. It makes for better surgery and for smoother convalescence, but it is not fool-proof, it will not make something out of nothing and the day will not come, in my opinion, when it will entirely supersede all other types of anæsthesia.

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TABLE I

Deaths which Occurred from All Causes in the Series of One Thousand Cases in which Spinal Anæsthesia was Used. All Cases Dying within Three Days are Included

Case	Diagnosis	Operation	Circumstances of Death
(I) W. D. D., 45. Retired of- ficer, U.S.A.	Intestinal obstruction, acute (three days' duration) from volvulus of small gut; <i>in extremis</i> when first seen.	Right rectus incision through old abdominal scar. Omental adhesions separated. Entire small gut from upper jejunum to ileocæcal region enormously distended and ileum dark. Small bowel drained in six or seven places with trocar and catheter and openings closed. Bowel milked of two or three quarts of contents. No definite point of obstruction found.	Death forty-eight hours post-operative. Toxæmia from obstruction.
(II) C. H., 37. Soldier	Massive hæmatoma in gastric colic omentum size of grapefruit extending behind posterior wall of stomach to diaphragm on left. Ruptured pancreas. Accidentally incurred by being kicked by a horse in abdomen.	Incision and drainage of hæmatoma. In evacuating contacts of about 700 cubic centimetres stomach wall turned out through rent in the mesentery and ascertained to be uninjured. Pancreas was badly torn, no repair was possible.	Death forty hours post-operative. Rupture of pancreas.
(III) Mrs. D. H., 30	Appendicitis, chronic. Retroversion uterine, severe.	Mid-line incision; appendectomy. Suspension of uterus, modified Gilliam. Dilatation and curettage.	Statuslymphaticus. Death forty hours. Autopsy did not disclose cause of death.
(IV) V. C., 25. Soldier	GSW perforating abdomen. Wound of entrance level of umbilicus eight centimetres to left. Wound of exit right gluteal region with multiple perforations of mesentery and small intestine. Peritoneal and retro-peritoneal hæmorrhage.	Laparotomy with repair of intestinal and mesenteric perforations; closure with drainage. Saline 2,000 cubic centimetres intravenously. Two blood transfusions; one before operation and one following.	Death in twenty-four hours from shock of multiple gunshot wounds.
(V) Mrs. C. W., 50	Nephrolithiasis, right.	Nephrectomy. The pelvis of the kidney contained a large staghorn	Cerebral embolism.

HAROLD WELLINGTON JONES

TABLE I (Continued)

Case	Diagnosis	Operation	Circumstances of Death
		stone filling calyces and pelvis. Kidney functionless and pelvis so damaged the kidney was removed. Serious respiratory embarrassment occurred on the table.	
(VI) H. L. T., 37. Soldier	Contusion, severe, abdominal. Fracture of 6, 7, 8, 9 ribs, axillary line, left. Rupture of ileum with multiple contusions of ileum and traumatic peritonitis. General peritonitis. Wound, lacerated, left groin.	Abdominal section, left rectus 10-inch incision. Repair of ruptured ileum with end-to-end anastomosis. Drainage. Operation performed twenty-four hours after injury.	Patient died of general peritonitis with tetany three hours after operation concluded.
(VII) R. B. L., 35. Officer, U.S.A.	Cholecystitis, chronic, suppurative. Persistent sinus at site of cholecystostomy in December, 1930.	Right rectus incision; cholecystectomy.	Hepatitis, acute, with early abscess formation. Myocarditis, acute, toxic severe with cardiac dilatation. Localized peritonitis. Temperature 105° at death.
(VIII) F. W., 70. Veterans' Bureau Beneficiary	Intestinal obstruction (ileus) acute, due to acute cholecystitis. Complicating myocarditis, chronic. Nephritis, chronic.	Abdominal section, right rectus incision. Small intestine showed recent signs of recent distention. Gall-bladder buried in omental adhesions, would not empty and contained stones. Obstruction relieved manually and by spinal anæsthesia. Bowel movement on table.	Death thirty-six hours. No further cause found at autopsy other than set forth in complications.
(IX) Mrs. F. L., 34	Retroversion, uterine, severe. 2, Cysts, multiple, ovarian, left. 3, Adhesions of colon to broad ligament. Post-operative ileus (forty-eight hours)	Mid-line incision; suspension, uterine, Gilliam method. Separation of adhesions. Removal of ovarian cysts. Ileostomy to left of umbilicus. Coils of ileum were moderately distended and red, but there was no evidence of peritonitis.	Paralytic ileus. Death sixty hours post-operative. Autopsy, diagnosis confirmed.

SPINAL ANÆSTHESIA

TABLE I (Continued)

Case	Diagnosis	Operation	Circumstances of Death
(X) T. O. B., 36. Veterans' Bureau Beneficiary	Colitis, spastic, mild, cause undetermined. 2, Cholecystitis, chronic. 3, Cholelithiasis.	Cholecystectomy, tube drain. Gall-bladder contained numerous small stones. It was embedded in omental adhesions.	Myocarditis with failing compensation. Temperature 106° at death.
(XI) C. B. S., 24. Soldier	Rupture, traumatic, upper jejunum. Severe contusion, left side of chest. Collapse of left lung. All due to accidental trauma.	Left rectus incision; closure of rupture in jejunum; two rows of sutures. Jejunostomy just below point of rupture. Closure with No. 16 catheter in jejunum.	Pneumonia broncho all lobes both lungs. General peritonitis. Autopsy diagnosis.
(XII) J. D. P., 42. Soldier	Acute surgical abdomen, type undetermined, manifested by extreme epigastric pain, vomiting and upper abdominal rigidity.	Exploratory laparotomy. Acute pancreatitis.	Acute hæmorrhagic pancreatitis. Death eight hours post-operative.
(XIII) G. C. B., 40. Veterans' Bureau Beneficiary	Appendicitis, acute, suppurative, with general peritonitis.	Appendectomy; grid-iron incision. Appendix was removed in fragments, retrocæcal.	General peritonitis. Death thirty hours post-operative.
(XIV) J. B., 31. Soldier, Air Corps	Appendicitis acute, suppurative, with general peritonitis.	Appendectomy; grid-iron incision, free pus, drainage.	General peritonitis. Death seventy-two hours post-operative.

ACUTE INTUSSUSCEPTION IN INFANCY AND CHILDHOOD

A REVIEW OF SIXTY-FOUR CASES

BY EDWARD W. PETERSON, M.D., AND RUPERT FRANKLIN CARTER, M.D.
OF NEW YORK, N. Y.

DURING the past twenty-four years the patients in this group of sixty-four cases have made up the principal subject matter in several papers: Two on acute intestinal obstruction and two on intussusception alone. The study of a series of patients as they occurred over a period of twenty-four years and the contrast presented by the present additional eighteen cases to the previously reported forty-six bring out interesting points in the factors of diagnosis, treatment and mortality percentages.

The present group of eighteen cases that have occurred on our service since the last report in 1922 were operated upon by: Doctor Peterson, seven; Doctor Silleck, three; Doctor Salisbury, three; Doctor Carter, five.

Age.—In the new series of eighteen cases, thirteen occurred in infants under twelve months of age and five in the second year, the youngest in the series being three months old and the oldest two years. In the previously reported cases, thirty-nine were in infants under thirteen months of age and seven in older patients of from twenty months to eight years, the youngest being six days old and the oldest eight years.

Sex.—There were ten males to eight females in the new group; and in those previously reported there were thirty-one males to fourteen females.

Clinical Picture.—In the previously reported cases, the past history is classified by the general condition of the child and the physical condition of thirty-six of the infants was given as being exceptionally good, two in fair shape and one subnormal. The majority were breast-fed and only two were on artificial feedings exclusively.

A review of the past history of the eighteen recent cases reveals: No abdominal symptoms in eight cases; constipation in four cases; vomiting attacks in five cases; cramp attacks in three cases; diarrhoea with bloody streaks of mucus in four cases; and in three cases there had been definite attacks of vomiting, abdominal pain and diarrhoea with blood in the stools. In one case the attack occurred one week before, in another two months before, and in a third there had been attacks of this kind over a period of three months before the final complete obstruction occurred.

The present history of the additional eighteen cases in which the symptoms are recorded in every instance shows: Pain recorded as cramps or pain in nine cases; vomiting in eighteen, fecal in one; bloody mucous stools in eighteen, either before or after coming to the hospital. On examination a mass was recorded as being present in fifteen cases; five situated in the right lower quadrant, four in the right upper quadrant, three in the upper

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quadrant, one in the left upper quadrant, and two were felt only by rectum. The average duration of the onset of the symptoms was thirty-two hours; there were two having had symptoms of 120 hours and two with symptoms of nine hours' duration. Twelve cases had had symptoms for twenty-four hours or longer.

In the discussion of those symptoms as given in the previously reported cases, pain was uniformly present; vomiting in every case; bloody mucous stools in about 95 per cent.; and a tumor was felt in every case with but two exceptions.

A comparison of the past history between the present and previous groups of cases cannot be accurately made because of the differences in the history charts, but many of the old histories were worthless and it was only by subsequent questioning of some member of the family that the true story was obtained.

In the present histories the degree of shock and general appearance mentioned in the old reports could not be brought up to date except by an opinion just as that given previously had been, and shock in the early cases depends on the amount of strangulation of the mesenteric blood supply. Invagination without strangulation gives practically no shock in the early hours.

In the previous cases pain was given as being uniformly present; pain occurs in every case of intestinal obstruction, and closer questioning would probably show that it was present in all eighteen cases in this last series, and in the present group it was recorded in nine instances; vomiting was present in every case in both groups; bloody mucous stools in forty-four of the old forty-six cases and in eighteen of the present eighteen; a tumor was felt in forty-four of the forty-six old and eighteen of the eighteen new cases.

Etiology.—In the majority of instances of reports on intussusception there has not been given a cause of sufficient frequency to become suggestive as an underlying principle or real cause for the invagination. In the old groups of this series of sixty-four cases there was noted in two a Meckel's diverticulum as a causative factor; in one a cyst adenoma of the cæcum; in another an inflammatory thickening of the lower ileum, not involved in the intussusception. Appendicitis was given as a probable cause and the removal of the appendix was recommended in the first of these reports in 1905. Enlarged mesenteric lymph-nodes were mentioned but not given as a cause but rather as a result of the intussusception.

In the present group of eighteen cases there was only recorded an instance of enlarged lymph-nodes as an additional factor. The appendix, however, was removed in every case but two; one of these was in an irreducible case that died on the table. The pathological report of the appendices removed showed in nine cases subacute inflammatory changes; in two, chronic inflammatory changes; in two, acute appendicitis; in one, gangrene;

in one, congestion; in one, a normal appendix, and the record was lost in one case.

Varieties of Intussusception.—In the previously reported cases there were according to the classification as suggested by Clubbe: Enteric, three cases; ileocecal, thirty-one cases; enterocolic or double intussusception (entero-ileocecal and ileocolic-colic), eight cases; colic, two cases; and, in two cases that were not operated upon, the type was not recorded. In the present group of eighteen cases there were: Enteric, no cases; ileocecal, five cases; entero-colic or double intussusception, eleven cases; colic, one case; unclassified, one case.

Gangrene.—In the previous reports on forty-three cases there were fifteen cases in which there was either gangrene or an irreducible intussusception present requiring a resection. In the present group of eighteen cases there were two with gangrene that were also irreducible.

Operation.—In the previously reported cases, one case died as the operation was begun; one case died prior to operation; one case reduced without operation; twenty-eight cases were reducible; and fifteen cases required resection. In the present group, all the cases were operated upon; one case died on the table with an irreducible intussusception; sixteen cases were reducible; and one case with an irreducible intussusception required resection.

Mortality.—In the forty-three cases previously reported, there were twenty-two cures and six deaths (from all causes to three weeks after operation), a mortality of 21.42 per cent. in the cases in which reduction was possible. And in the fifteen cases requiring resection, there were four recoveries and eleven deaths, a mortality of 72.4 per cent. In the present group of eighteen cases, there was one death in sixteen reducible cases, or a mortality of 6.25 per cent., one death on the table in an irreducible case that was moribund and one recovery from a resection of a gangrenous appendix, cæcum and ascending colon.

For the entire series of sixty-four cases, among the reducible cases there have been thirty-eight recoveries and seven deaths, or a mortality of 15.5 per cent., and among the irreducible cases there have been five recoveries and twelve deaths, or a mortality of 76 per cent.

There were sixty-one cases operated upon for intussusception, with forty-two recoveries and nineteen deaths, or a total surgical mortality of 31 per cent.

In the previously reported group of patients, there was one death in an infant that was seen within the first forty-eight hours of the onset of symptoms, death being due to influenza pneumonia.

In the added group of eighteen cases there were no deaths in those patients in which the operation took place within forty-eight hours of the onset of symptoms. There was one death in a reducible case in which the infant expired ten hours after reduction of an enterocolic intussusception that took place in the hospital while the child was under observation for the diagnosis of rectal polypii which were not present.

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In the previously reported cases, the diagnosis by X-ray was mentioned and advocated as a differential diagnostic means in doubtful cases. In this series it was employed in two instances: in one a gastro-intestinal series showed an obstruction in the lower ileum in an infant that had been having symptoms of partial obstruction for two months. Operation revealed a gangrenous intussusception. A Friedrich operation was performed with a lateral anastomosis between the ileum and transverse colon with recovery and normal function to date, two years afterward.

In the second case in which a probable diagnosis of rectal polpi had been made and in which sigmoidoscopic examination revealed no polypus, a barium enema showed an obstruction in the left colon and later a mass was demonstrated and the diagnosis of intussusception made.

In every instance in this last series of eighteen cases the diagnosis of intussusception was made and recorded before operation.

SUMMARY

The continued occurrence of intussusception in spite of the great improvements in feeding with the decrease in cases of diarrhoea among infants retains this condition in that group of diseases for which active treatment instead of prevention must prevail.

Preparation for operation still is limited because of the severity of the condition together with the acute onset and the delay in diagnosis and operation.

In recurring intussusception or intussusception without obstruction or strangulation of the blood supply, the X-ray is an aid in diagnosis, but the barium enema should be given first.

Operation upon patients with strangulation, obstruction and gangrene still carries a high mortality when every means of treatment of these conditions is employed; and, though an occasional patient may survive the resection of intestine, the only means of reducing the high mortality in these patients is by operating for the intussusception before gangrene occurs.

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PERICOLIC MEMBRANES *

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FROM THE SURGICAL SERVICE, ST. JOHN'S HOSPITAL

IT HAS been said that there are two kinds of appendicitis—acute appendicitis and appendicitis for revenue only—and it is to those cases of the revenue group, incorrectly diagnosed as chronic appendicitis, that we wish to call your attention.

There are four separate and distinct types of membranes occurring with relative frequency in the lower right abdomen:

First.—Post-operative adhesions with which we are not now concerned.

Second.—The so-called Jackson's membrane involving the upper ascending colon and at times nearby portions of the transverse colon. We are told that these are formed to afford additional support for the large bowel in cases of enteroptosis. This may be in some instances but in others we believe them to be due to an entirely different cause of which we will speak later.

Third.—The so-called Lane's band found within the last 12 to 14 inches of the ileum. These are unquestionably congenital.

Fourth.—Pericolic membranes involving the cæcum and lower part of the ascending colon.

It is the last-mentioned variety that we wish particularly to emphasize. They were first described by Jonnesco but unfortunately at a time when the thought of the entire world was focused on the European War and they have not received the attention they merit. Aside from Jonnesco's article there is practically no literature on the subject with the exception of an article by Bigelow, of Brandon, Manitoba, appearing in the July, 1930, issue of the Canadian Medical Association Journal. He reviews 1,027 cases of his own but in his short paper confines himself largely to the one symptom of lower right abdominal pain.

The larger surgical text-books treat the subject with but scant courtesy and, in our judgment, entirely miss the point by advising against all interference with such membranes (usually only mentioning Jackson's) unless they are causing obstruction.

Paradoxical as it may sound and seem pericolic membranes, at certain ages, may produce mild obstructive symptoms, obstinate constipation, without directly producing obstruction. Their effects are definitely reflex, affecting the pylorus and transverse and descending colon as has been demonstrated repeatedly in approximately 200 personal cases on which this paper is based.

Pericolic membranes are undoubtedly congenital and consist of a reduplication of the parietal peritoneum extending up on to the side of the cæcum and from which they can be separated with a few light touches of a scalpel

* Read before the Brooklyn Surgical Society, February 4, 1932.

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which causes no bleeding. Frequently they extend around the lower end of the cæcum and here have a tendency to shorten the meso-appendix and produce angulation. Less frequently they extend up the ascending colon and become blended with Jackson's membranes if these have been developed.

In our series of cases females constituted 68 per cent. and males 32 per cent. Fourteen per cent. occurred in the second decade, 44 per cent. in the third decade, 23 per cent. in the fourth decade, 11 per cent. in the fifth decade and 5 per cent. were over fifty years of age. Thus it will be seen that 67 per cent. of cases were between the ages of twenty and forty.

In approximately 10 per cent. of our cases the appendix had previously been removed, leaving the patient with the same symptoms which existed prior to its removal. This figure corresponds with Bigelow's experience, he having 107 cases of previous removal of the appendix out of a total of 1,027 cases.

The symptomatology varies with the age of the individual but constipation is usually, though not invariably, present and the membranes are more common in the thin, flat-chested individual, the subject in whom an enteroptosis would be expected. We have sectioned the membranes in a fairly large number of such patients and have been gratified by having them put on so much flesh that no further treatment for the enteroptosis was needed.

If we classify symptoms according to age groups we shall obtain a clearer picture.

Decades	2nd	3rd	4th	5th	6th
Constipation.....	53%	53%	58%	64%	59%
Right iliac pain.....	100	83	64	42	57
Right iliac tenderness.....	70	58	50	35	42
Nausea.....	23	37	29	21	29
Vomiting.....	17	19	22	28	42
Epigastric pain.....	0	19	32	35	42
Flatulency.....	0	32	22	42	29
Digestive disturbance.....	6	11	13	21	14

(The term "digestive disturbance" has been used to cover the more-or-less indefinite complaints of epigastric fullness, heaviness, etc.)

First it will be noted that constipation is present in more than 50 per cent. of the patients of all ages. The local and reflex symptoms show interesting variations. Right iliac pain and tenderness are complained of in a large percentage of those in the second and third decades but diminish in the later decades. Nausea and, particularly, vomiting are increasingly present with increasing age as are also epigastric pain and flatulency. In brief, as age increases the local right iliac symptoms become less and the reflex symptoms caused by pylorospasm increase.

As might be expected there is no alteration in pulse, temperature nor blood count.

The typical history is one of recurring attacks of lower right abdominal pain and tenderness (varying with the age) and frequently made worse by exercise. Seldom is there a history of an attack sufficient to demand rest in bed. Later in life the attacks are more suggestive of gall-bladder disturbance

or duodenal ulcer and most of the older patients can be temporarily relieved by alkalies and antispasmodics.

Physical examination is essentially negative except that where tenderness is present it is usually diffused over the cæcum and ascending colon.

The Röntgen-ray findings are typical and convincing but are frequently overlooked or misinterpreted. Doctor Knapp, our röntgenologist at Saint John's Hospital, prefers to depend largely upon the fluoroscope for the stomach examination and this we have found highly satisfactory, though usually a few pictures are made as a matter of record. The stomach is usually hypermotile with almost invariably a marked pylorospasm frequently causing a small six-hour residue.

The cæcum is usually smooth, particularly on its outer border, and its lower extremity cone shaped. The usual incisures in the ascending colon are shallow or absent, giving the impression of a bowel surrounded by an invisible veil limiting peristaltic action. There may be reduplication and fixation at the hepatic flexure and here again the fluoroscope comes into play in determining whether the ascending and transverse colon are actually adherent in a sharply angulated position. Almost constantly there is marked spasticity and contraction of the distal transverse colon and the descending colon. The ileum usually enters the cæcum at a very acute angle and there is frequently a marked ileo-cæcal delay—a small bowel constipation.

Returning to the subject of Jackson's membranes, which we are told have been developed to hold up a right colon which is falling into the pelvis we stated earlier in the paper this may be so in some cases but it certainly is not true in all, for in many of our cases we find the cæcum in a normal or even high position with no signs of enteroptosis but with Jackson's membranes much in evidence. What we do find in practically all cases (by X-ray) is a markedly spastic transverse or descending colon, usually the latter, and we believe that these membranes are formed as the result of bowel effort in attempting to pass its contents through a more-or-less chronically contracted distal portion. We furthermore believe that the binding together of the ascending and transverse colon in a position of sharp angulation at the hepatic flexure is due to a combination of trauma (slight to be sure) of faecal masses plus a low-grade inflammation due to stasis. In addition to the deforming membranes at this point we frequently encounter enlarged mesenteric glands.

Many of these patients, particularly those between the ages of twenty and forty, come to operation because of upper abdominal symptoms due to pylorospasm, and as the trauma of operation in the right iliac fossa increases the spasm we have found that their immediate post-operative period has been made more comfortable by the administration of belladonna, bromides and alkalies for a few days preceding operation. With such preliminary treatment there has been much less upper abdominal distention with its accompanying nausea and vomiting.

A right paramedian incision retracting the right rectus muscle to the right has seemed on the whole most logical. To be sure, such an incision is

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not directly over the part to be attacked but it can be enlarged in either direction without permanent damage to the abdominal musculature or its nerve supply. A moderately long incision may be necessary in order that the entire right colon and hepatic flexure may be inspected and appropriately treated. Here it may be said that a study of the X-ray pictures may be helpful in planning the incision. If the region of the hepatic flexure is above suspicion a low, moderately short incision is all that is necessary.

Upon opening the abdomen the terminal ileum is first inspected for Lane's bands which are sectioned if found. They will be found with relative frequency if routinely sought for. Next any pericolic membranes are pushed back after a few light touches with a scalpel. If the proper line of separation is found there will be no bleeding. Jackson's membranes are not disturbed unless they have extended across and are constricting the ascending colon or have produced a fixed angulation at the hepatic flexure. In either of these events the greatest gentleness is exercised in separating them, great care being taken to find, if possible, a natural line of separation. As has been said earlier we look upon these as being in part at least inflammatory and consequently likely to be reformed in contradistinction to the pericolic membranes which are congenital and show no tendency to recur. Finally the appendix is removed and the wound closed without drainage.

Upon return to bed these patients are given a small enema containing 60 grains of sodium bromide and 10 grains of chloral hydrate. This has been in use but a short time but the results have been satisfactory and encouraging. Operative trauma increases the preëxisting pylorospasm and gastric distention results. It is well known that morphine is of little value in controlling pylorospasm and thus the use of bromides by rectum. A fairly prompt return to a full laxative diet, aided where necessary by mild laxatives, practically completes the picture. Our greatest trouble has been that when these patients return home they are filled with milk and eggs, become constipated and lose their appetites. A proper diet and proper exercise will almost invariably correct this.

One of the most striking changes is rapid increase in weight but there are a few patients markedly underweight and with an enteroptosis who will need treatment for this condition. This number, however, will be small. There is also a small group, usually in the fourth and fifth decades, who have suffered severely with pylorospasm and constipation for long periods who at times of mental stress and fatigue will have a return of symptoms. This tendency seldom persists for more than six months and responds promptly to sedatives and alkalies as mentioned earlier in the paper.

In concluding, we make the plea that pericolic membranes be thought of when one is tempted to make the diagnosis of chronic appendicitis in the adolescents and that they be thought of in those beyond the second decade presenting atypical symptoms suggesting gastric or duodenal ulcers. Is it possible that this iliac fossa irriation which so definitely and distinctly produces pylorospasm with its accompanying hyperacidity may be an etiological factor in gastric or duodenal ulcer?

THE KERR TECHNIC IN RESECTIONS OF THE COLON*

BY JOHN H. GIBBON, M.D.

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THE operation of intestinal resection probably has more names attached to it, indicating individual, if not original methods, than any other operation in the whole field of surgery. The paramount obstacle to success is infection, the dangers of which increase as one advances toward the rectum, and for decades the endeavor of surgeons has been to obviate this risk.

The popularizing of the two- and sometimes three-stage method of colonic resection (especially of the transverse and descending colon and sigmoid) about thirty years ago marks one of the great advances in abdominal surgery. The name of Mikulicz is irrevocably but erroneously attached to this operation, though through no act of his own. It was first suggested by Block in 1892, but probably first practised and published by Paul, of Liverpool, in 1895. Moynihan says that in France Hartmann is given the credit "by those afflicted with the quaint Gallic frugality of recognition of the work of others." In spite of the greatly lowered mortality following the two-stage operation, scores of new methods of resection and immediate anastomosis continued to appear, usually with the title of "aseptic." Many of these were appealing, and disliking the Paul-Mikulicz operation, for obvious reasons, I employed a number of them. In 1921 I did my last Paul-Mikulicz operation.

In 1923, Harry Kerr (*Journal of the American Medical Association*, vol. lxxxi, p. 641) of Washington, D. C., described what he called the "basting-stitch" technic which seemed to me much simpler and more nearly approaching an aseptic operation than any of those which I had tried. I used it in my next case (April 25, 1924) and since then in every case of anastomosis where I thought it applicable. The accompanying table shows what the results have been.

At the last meeting of the American Surgical Association in San Francisco, Kerr showed a moving picture of the technic as applied in resection of the cæcum and the following quotation is from his text (*ANNALS OF SURGERY*, October, 1930):

"A pair of crushing clamps is applied at right angles to the bowel axis in as close approximation as possible. One pair on the ileum; one pair on the transverse colon. The bowel is divided between each pair of clamps by the cautery which destroys any tissue remaining between the crushed clamps. The basting stitch is now applied. A stout linen suture is used in a curved round needle. The basting stitch consists essentially of a continuous suture, without knots, to temporarily close the intestinal incision, a separate suture be-

* Read before the conjoined meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, February 10, 1932.

RESECTIONS OF THE COLON

TABLE OF CASES

NAME AGE HOSP. DATE	DIAGNOSIS	OPERATION	WOUND INFECT.	FECAL LEAK	OPERATIVE DEATHS	SUBSEQUENT DEATHS	RESULTS
1. R. E. 40 JEFF. HOSP. 4/31/21.	DIVERTICULITIS DESCENDING COLON AND SIGMOID.	RESECTION (SHOEMAKER) NO CECOSTOMY	YES	YES			REMAINS WELL
2. M. S. 40 PENN. HOSP. 5/2/23.	TUBERCULOSIS OF CECUM AND MECKEL'S DIVER- TICULUM.	RESECTION CECUM " " DIVER- TICULUM		LIGHT			REMAINS WELL
3. G. A. S. 53 PENN. HOSP. 1/2/24.	CARCINOMA OF SIGMOID.	RESECTION (COLLIER) PRELIM. CECOSTOMY.	YES	YES	7th DAY FROM LOCAL INFECTION		
4. E. S. G. 51 PENN. HOSP. 4/25/24.	CARCINOMA OF SIGMOID	RESECTION (KERR) NO CECOST. RECTAL TUBE ABOVE ANASTO- MOSIS.	YES	NO			REMAINS WELL
5. J. E. P. 54 PENN. HOSP. 6/13/24.	CARCINOMA OF CECUM AND AS- CENDING COLON	RESECTION (KERR)	NO	NO			REMAINS WELL
6. MRS. K. 70 JEFF. HOSP. 12/1/24.	CARCINOMA OF HEPATIC FLEXURE LIVER AND STOMACH.	RESECTION OF CECUM ASCENDING AND TRANS. COLON - ALSO GALL BLADDER PORTIONS STOMACH AND LIVER (KERR)			24 HRS. FROM SHOCK		
7. MRS. B. 59 BRYN MAWR HOSP. 1/11/26.	CARCINOMA OF SIGMOID	RESECTION (KERR) NO CECOSTOMY	YES	YES			REMAINS WELL
8. MRS. S. 46 JEFF. HOSP. 5/11/26.	CARCINOMA OF CECUM AND AS- CENDING COLON. PERITONEAL ME- TASTASIS.	RESECTION (KERR)	NO	NO		DIED 4 MOS. AFTER OPERATION.	
9. W. H. S. 39 PENN. HOSP. 10/25/26.	TUBERCULOSIS OF CECUM AND ILEUM	RESECTION (KERR)	NO	NO			REMAINS WELL
10. A. W. 37 PENN. HOSP. 11/24/26.	CARCINOMA OF TRANS. COLON AND SIGMOID.	RESECTION (KERR) NO CECOSTOMY	NO	NO			REMAINS WELL
11. J. B. Mc C. 32 JEFF. HOSP. 2/12/26.	CARCINOMA OF DESCENDING COLON.	RESECTION (KERR) NO CECOSTOMY	NO	NO			REMAINS WELL
12. DR. T. 71 PENN. HOSP. 10/22/28.	CARCINOMA OF TRANS. & DESCEND- ING COLON, LES LOCATED FOR STAXIA	RESECTION AND SUTURE (NOT KERR) COLOSTOMY	YES	?	12th DAY IN- FECTION. NO PERITONITIS.		
13. D. P. 61 PENN. HOSP. 11/16/28	CARCINOMA OF SIGMOID	RESECTION (KERR) NO CECOSTOMY	YES		7th DAY PERITONITIS. ABDOMEN RE- OPENED AND DRAINED 4th DAY.		
14. MRS. B. 32 JEFF. HOSP. 3/19/29.	CARCINOMA OF TRANS. COLON	RESECTION (KERR) PRELIM. CECOSTOMY & NUMEROUS TRANS- FUSIONS.		YES			REMAINS WELL POST-OPPR. SUPPURATIVE PAROTIDITIS
15. MRS. H. 54 PENN. HOSP. 3/10/29.	CARCINOMA OF SIGMOID MALIGNANT CYST OF L. OVARY. NO CONTACT BETWEEN LESIONS. PERITO- NEAL METASTASIS. OVARIOCTOMY 2/20/29.	RESECTION (KERR) PRELIM. CECOSTOMY.		YES		REOPERATED UPON 4/7/31 FOR MALIGN- ANT CYST RIGHT OVARY. RECURRENCE AT SITE OF RESECTION. DIED 2 YRS. AND 1 MO. AFTER RESEC- TION.	
16. A. A. S. 67 BRYN MAWR HOSP. 5/16/29.	CARCINOMA OF SIGMOID	RESECTION AND CECOSTOMY (KERR)	NO	NO			REMAINS WELL
17. MRS. W. 67 PENN. HOSP. 9/23/29.	CARCINOMA OF DESCEND. COLON METASTASIS TO LIVER.	RESECTION (KERR) PRELIM. CECOST. FOR AC. OBSTRUCTION	NO	NO		DIED HEPATIC METASTASIS 1 YR. & 3 MOS. AFTER RESEC- TION.	
18. E. F. 58 PENN. HOSP. 1/5/30.	CARCINOMA OF CECUM	RESECTION (KERR)	NO	NO			LIVING BUT HAS RECURRENCE.
19. F. G. 59 JEFF. HOSP. 2/4/30.	CARCINOMA OF CECUM.	RESECTION (KERR)	NO	NO	SUDDENLY ON 4th DAY. AU- TOPSY SHOW- ED NO LEAK OR PERITONITIS.		
20. MRS. Mc C. 56 PENN. HOSP. 7/1/30.	CARCINOMA OF DESCEND. COLON	RESECTION (KERR) CECOST. PRELIM. ILEO- SIGMOIDOSTOMY, DONE ELSEWHERE FOR OB- STRUCTION.	NO	NO			REMAINS WELL

ing used for each of the bowel ends. On account of their method of application and temporary purpose they serve, they bear a certain likeness to the 'basting' stitches of the seamstress, and for convenience we have called them by that name. The first and last bites of the basting stitch are placed parallel to the axis of the bowel.

"The intervening bites are placed parallel to the crushing clamp *across* the axis of the bowel with the loops between the stitches crossing over the clamps. The crushing clamps are withdrawn from beneath the loops of the basting stitches. The basting stitches are then drawn taut, invaginating the complete bowel circumference, and producing peritonization of the entire stoma. The mesenteric defect is obliterated by this invagination.

"The closed bowel ends to be anastomosed are swung on their respective basting stitches in apposition, ready for suture. A single anastomosing suture is all that is necessary. Single O chromic catgut is used on an eyeglass needle. When the anastomosis has been completed, the basting stitches are cut close to the bowel, one at the mesenteric border, and the other at the free border. The basting stitches are withdrawn. The bowel wall is then invaginated through the stoma to break up the agglutination caused by the crushing clamps and cautery."

To add anything to this simple and satisfactory technic would seem impossible, but in giving my experience with it, it would seem only right to mention any variations which have been practised. In the first place I have lacked the assurance to depend on a single continuous suture, and with one or two exceptions have always used a second. In nearly all of the cases here reported the smallest Payr clamp has been used for crushing and although it makes a wider diaphragm it has seemed to lessen the possibility of leakage during the subsequent steps of the operation, and as none of my recorded cases has had any functional trouble, the wider band of bowel inverted would seem a theoretic rather than an actual objection. One point which Kerr has emphasized and which is important is the placing of the clamps at such an angle on the bowel as to make the resulting stoma of larger calibre than the normal bowel. This is very important in resections of the small intestine. In one case the linen thread used for invagination broke and I had some difficulty in removing it, since when I have used flexible silk-worm gut.

Spinal anæsthesia has greatly facilitated the performance of the operation in our recent cases.

In the cases of resection of the cæcum here reported the end-to-side method was used and in none was a preliminary or accompanying ileostomy done.

I would not advise a colon anastomosis without preliminary or accompanying cæcostomy. The preliminary cæcostomy is always indicated where there is an acute obstruction or where there has been enough obstruction of the chronic type to cause distention and œdema of the bowel proximal to the lesion. Probably every surgeon has regretted yielding to the temptation to

RESECTIONS OF THE COLON

do an immediate resection and anastomosis in these types. The bowel wall is teeming with bacteria and its circulation is poor. It will be seen in the table that I have done five resections without a cæcostomy. One of these cases died of peritonitis and I have the feeling that he might have lived had I done a cæcostomy; the others recovered. All of the cæcostomies, in the patients who lived, have closed spontaneously.

There were three resections done in the presence of metastasis (Cases VIII, XV, and XVII). In Case VIII, because of the multiple lesions in the colon, I thought they might be tuberculous and disregarded the peritoneal metastasis. In Case XV resection was necessitated by obstruction and was done in spite of peritoneal extensions from a malignant ovarian cyst. In Case XVII resection was done in order to avoid an artificial anus, in spite of a malignant nodule in the liver.

The operative deaths in the whole group (twenty cases) were five. Two of these, however, can hardly be attributed to the type of colon resection employed. One patient died suddenly on the fourth day and the autopsy revealed no peritonitis or leakage. In the other not only was the colon resected, but also a portion of the gastric wall and quite a block of the liver with the gall-bladder; this patient died of shock. There were three late deaths. Eleven of the twenty patients are living and well and one is living but has a recurrence.

Seventeen operations were done for carcinoma and among them occurred the five operative deaths. Three died subsequently: One at four months, one at fifteen months and one at twenty-five months, but all had metastasis at the time of resection. Eight patients in this group are well from eight years to eighteen months after operation. One is living, but has a recurrence.

Two of the remaining three patients had tuberculosis of the cæcum and one an extensive diverticulitis of the colon—all three remain well.

A glance at the table of cases will show that there are four in which the Kerr technic was not used. My reason for including them was that I wished to report all colon resections since I had ceased to do the Paul-Mikulicz operation. If we exclude these four cases the results in the remaining sixteen (Kerr) are somewhat better. In these sixteen cases there were three operative deaths. In the three subsequent deaths, all of which occurred in this group, metastasis was present at the time of operation. The patient now living but with a recurrence belongs in the Kerr group. The remaining nine of these sixteen patients are well at the present time.

If one is warranted in drawing conclusions from so small a number of cases, it would seem that the "basting-stitch" method of Kerr can replace the Paul-Mikulicz operation without increasing the mortality rate and with better ultimate results. Its greatest advantage to my mind is that one does a much wider resection of the bowel and mesentery than is often possible in the other type of operation.

The results in this series of cases tend to confirm the impression that cancer of the colon, if resected before metastasis has occurred, offers an ex-

cellent chance of cure. All of the patients in this group who recovered from the operation and who did not have demonstrable metastasis at the time, have with one exception, remained well from eighteen months to eight years. One of the cases of cancer of the sigmoid was in a man of thirty-two years and he has remained well four years.

DISCUSSION.—DR. FREDERICK W. BANCROFT (New York) said that if we are to be successful in eradicating cancer it must be by anatomical excision along lymphatic and vascular planes, and assuredly this is more safely carried out by resection as he has described. Where there is an obstruction or partial obstruction and we have satisfactory pre-operative localization by means of the barium enema, which is always to be advised rather than barium by mouth, a two-stage operation is the safest procedure. Where the growth is in the transverse, descending colon or sigmoid, a preliminary cæcostomy, as a decompressing procedure, through a McBurney incision, with no abdominal exploration, is a very advisable procedure. Any exploration at that time in a poor operative risk increases the mortality and may complicate the subsequent operation. Fortunately cancer of the cæcum or ascending colon is not apt to be obstructive, for in this region a primary cæcostomy would interfere with the later excision of the growth. If a two-stage operation is advisable, a preliminary ileocæcostomy may be done with resection at the second stage.

Kerr's method of the basting stitch is simple, does not need any pre-operative clamps and for this reason has the advantage over the Rankin method with his individual clamp. Kerr's advice to cut across the bowel obliquely is an excellent procedure in that it offers better circulation for the suture line and tends to prevent diminution of the size of the lumen. Doctor Bancroft exhibited an instrument that he has used at the Fifth Avenue Hospital for intestinal resections, which in his hands has proven very satisfactory; the von Petz clamp which resembles a Payr crushing clamp but also has a mechanism for inserting a double layer of staples across the bowel. When these staples have been inserted the bowel can be cut across between the two lines, with either a carbolyzed knife or a cautery, which prevents spilling and makes a relatively aseptic procedure. The line of staples can be rapidly whipped over with an ordinary inverting suture. This method is particularly applicable where one wishes to make a lateral anastomosis. It is also applicable in carcinoma of the rectosigmoid in the combined abdominal-peritoneal operation. The proximal end may be brought up through a left McBurney incision for a colostomy and the layer of staples excised when opening the colostomy. This procedure should diminish the risk of peritoneal soiling. X-rays taken post-operatively show that these staples persist *in situ* for a considerable period of time and are gradually extruded. In a recent case autopsied six months after an operation wherein a recurrence had taken place in the liver, the post-mortem examination showed that there was no foreign body reaction about a staple which still remained in the intestinal wall.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD JANUARY 27, 1932

The President, DR. JOHN DOUGLAS, in the Chair

RECURRING INTESTINAL OBSTRUCTION FROM GALL-STONES

DR. CONDUCT W. CUTLER, JR., presented a woman, sixty-three years of age, who had been admitted to the Medical Division of the Roosevelt Hospital in January, 1931, three and one-half months before her entry upon the surgical service. At her original admission, she gave a history of pain in the upper abdomen, periodically, for the previous two years. This pain had been increasingly severe in the preceding two days, coming on after meals and radiating to the back and shoulders, associated with eructations but no vomiting. There had been some loss of appetite and constipation. No jaundice. The patient had lost fifteen pounds in weight. At that time, she showed some abdominal distension and while under investigation began to complain of pain in the lower abdomen, cramps, obstipation and tenesmus. For a time her condition suggested incomplete obstruction.

A rectal examination being done, a large faceted gall-stone was discovered in the rectum. This was removed with some difficulty, and the patient was immediately relieved. She returned home for three and one-half months, and was quite well, although still complaining of occasional fullness in the epigastrium, with a sense of soreness between the shoulder blades. On the day before her recent admission, she was suddenly seized with abdominal cramps and sharp pain in the epigastrium, radiating to the back. She was nauseated and vomited and abdominal cramps succeeded, increasing in frequency and in severity. Vomiting became more persistent and the vomitus assumed a fecal character. The abdomen had become distended and the bowels had not moved.

When admitted there was marked distension with visible peristalsis, the picture being distinctly one of acute intestinal obstruction. Immediate operation was performed. A distended loop of small intestine (lower ileum) was followed into the pelvis, at which point a large faceted gall-stone was discovered, impacted in the ileum. An enterotomy was done, the gall-stone removed and enterostomy tube introduced through the opening in the gut. This drained profusely, and she proceeded to a satisfactory and uncomplicated recovery. Her enterostomy tube was removed on the eighth day. The patient has been well since that time.

DR. CARL EGGERS said that one might speculate on how and where the gall-stones in these cases enter the alimentary tract. Do they pass through the cystic duct into the common duct and then by gradual dilatation of the papilla into the duodenum, or do they perforate through the gall-bladder wall directly into an adjoining portion of gut?

In the former case a long period of jaundice would probably precede the passage of the stone, while in the latter there need be no serious interference with function.

He has seen several patients with intestinal obstruction due to a large gall-stone, in none of whom was there any evidence of how the stone entered the

gut. He has, however, made an observation on the operating table in three cases which indicates that in two of these perforation into the duodenum was taking place, while in a third the colon was adherent over a large stone.

CASE I.—A lady of sixty-two years, who for years had had upper abdominal symptoms suggestive of gall-bladder disease, was operated on May 23, 1930, for a large ovarian cyst. After removing the cyst the gall-bladder was palpated and exposed. It contained one large calculus, apparently completely filling it. The pyloric end of the stomach and the duodenum were firmly adherent over it. It looked as if there were impending perforation. Nothing was done and the stone has not passed so far.

CASE II.—A woman, fifty-three years of age, was operated on for gall-bladder disease April 27, 1931. Röntgenologically she was a "no shadow" case. A mass of adhesions was found to occupy the region below the liver and to involve the distal end of the stomach as well as the duodenum and the omentum. Under great difficulty the gall-bladder was entered, and a large stone, one and a half inches in diameter, removed. It was firmly wedged in. As soon as it was removed there was a gush of fluid which looked like stomach contents. Examination showed it to come from the duodenum; they were dealing with a cholecystoduodenostomy, spontaneously produced, and no doubt in time the stone would have passed down into the duodenum.

CASE III.—An unmarried woman, forty-four years of age, was operated on for obstructive jaundice January 25, 1932. The gall-bladder contained four large stones, completely filling it. Over the lowest one at the fundus the colon had become firmly adherent. While carefully separating the two viscera the wall of each was found to be very thin and when the gut was completely freed it contained a perforation. Section of a fragment of this gut showed the mucous membrane to be destroyed over a wide area and replaced by exuberant granulation tissue richly infiltrated with inflammatory cells of various kinds, including numerous polymorphonuclear leucocytes. In this case evidently the gall-bladder would have perforated into the colon, allowing the stone to pass through into this part of the gut.

AGRANULOCYTOSIS ASSOCIATED WITH PERI-ANAL PHLEGMON

DOCTOR CUTLER presented a man sixty-one years of age. For two or three months preceding admission, the patient had not felt well. He had lost appetite and had lost some weight. For a number of years, he had noticed a nodule at the left side of the anus, which at times became somewhat swollen and painful. One week before admission, there was a recurrence of this pain and a swollen, tender area developed there. For the week preceding admission, he had had no bowel movement, complained of headache and increasing abdominal distension and discomfort. He had had no infectious disease in his past history. An initial lesion had been treated forty-five years ago. A Wassermann three years ago was negative. Patient had been a very heavy smoker, used alcohol in moderation. For the past year he had had slight dyspnoea on exertion. The patient's appearance was that of an exceedingly ill man, pale and undernourished. The abdomen was quite distended, with tympany throughout. There were no signs of tenderness or muscular rigidity and no masses were felt. The heart was somewhat enlarged but without adventitious sounds and with normal rhythm and rate. The lungs were clear. At the left side of the anus was a swollen, tender, reddened, fluctuant mass, the superficial area of which was necrotic. Patient's temperature upon admission was 102. His blood count showed hæmoglobin, 60 per cent.; red cells, 3,000,000; white cells, 450; polymorphonuclears, 18 per cent.; lymphocytes, 82 per cent.

Shortly after admission, the ischiorectal abscess was opened, and drained a quantity of pus. The patient's temperature began to subside somewhat but he was still exceedingly weak and ill. Attempts at emptying bowel by colonic irrigations were moderately successful, and gastric lavage was resorted to to control a persistent vomiting. Check-up

AGRANULOCYTOSIS ASSOCIATED WITH PERI-ANAL PHLEGMON

blood count was made to verify the extraordinary blood-picture and found to be essentially the same. On the fourth day after admission, his condition having shown relatively little improvement, a transfusion of 500 cubic centimetres of whole blood was made, following which some improvement in the blood-picture occurred, with almost immediate improvement in the patient's general condition. The vomiting had ceased and the distension became less marked and enemas were increasingly effective. The blood count gradually rose from 2,000 white cells, with 67 per cent. polymorphonuclears, on the second day after transfusion, to reach on the eleventh day after transfusion 10,000 white cells, with 89 per cent. polymorphonuclears. There was a consistent improvement during this period in the patient's condition and the peri-anal abscess completely healed.

Careful X-ray investigation of the intestinal tract showed no evidence of lesion. The urine showed nothing significant, beyond a little albumen and a few hyalin granular casts. Wassermann was negative. No growth was obtained on blood culture.

The patient was discharged in much improved condition and has subsequently been entirely comfortable, gaining in weight and strength.

Agranulocytosis was first described in 1922 by Schultz. Age 30 to 50 plus. Women 5 to men 1. Lesion usually throat or mouth. Frequently ulcerations in digestive tract as well. Cause.—Specific organism, endocrine or allergy? Symptoms.—Fever, headache, chill at onset. May follow period of general malaise. Local gangrenous lesion: 1 mouth, 2 vagina, 3 anus. Course.—Usually progressive to fatality. Treatment.—Transfusion. X-ray of bones.

DR. KIRBY DWIGHT said that the condition of agranulocytosis is more of a medical problem than a surgical one. Most of the studies on it have been made by medical men and it comes more into their field. But these cases are all the time getting into surgical wards because they have local lesions of a surgical nature, and frequently because the diagnosis of intestinal obstruction is made. The speaker first became interested in the subject two years ago at the Lincoln Hospital when a patient, a woman of middle age, was brought in with chills and fever and vomiting. She was placed in the surgical ward with a diagnosis of acute obstruction. That was soon changed and the diagnosis made of influenza, then typhoid fever, then septicæmia. The correct diagnosis of agranulocytosis was not made until the day of her death, and then by a medical man in consultation. The blood count at first was not suggestive; 11,000 leucocytes, 78 per cent. polymorphonuclears, but that went down on the day of her death, when she had a blood-picture of 5,000 leucocytes and no polymorphonuclears whatsoever. The previous history was of four somewhat similar attacks over a number of years, during two of which she was hospitalized, the diagnosis of agranulocytosis being made once at Bellevue. Autopsy showed ulcerations of the pharynx and base of the tongue, and marked œdema and induration around the lower rectum with a gangrenous area six centimetres in diameter. The nature of agranulocytosis is still in dispute as to whether it is a clinical entity or a constitutional condition. The former has been exploded by the wide variety of organisms found in the blood, all the way from *Staphylococcus aureus* to colon bacilli. The general opinion is that it is a disorder of the leucopoietic system whereby the patient is unable to work up resistance to infection in times of stress; where the blood count of the patient should go up it lies down under assault. At Johns Hopkins they have been following

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these developments in the case of a boy who has had ten or fifteen attacks. They have studied his blood-picture before the attacks and found that a fall in polymorphonuclears precedes the onset of the symptoms of the infection, and rises to normal before the infection has subsided.

DR. EDWARD D. TRUESDELL reported a case of agranulocytic angina coming under his care in 1923. This was an unmarried woman of forty-three years who had complained of severe pain in the rectum for three weeks. Six months before her tonsils had been removed and the tonsillar fossæ had remained unhealed. The Wassermann was negative; blood culture sterile; there were no Vincent's organisms in the throat; the white blood-cells 11,000; 80 and 20. No special morphology of the white cells was noted or particularly looked for. Her pain persisting and evidently severe, the anal sphincter was dilated under anæsthesia and a careful search for pathology in this region was made, but without results. Her temperature persisted, being between 102° and 104°. A phlegmon developed about the rectum which promptly broke down, and, sloughing rapidly, extended beyond the reach of the examining finger, until the death of the patient.

There was no autopsy and the case was closed under the diagnosis of "hæmorrhoids and sepsis." The patient had been seen by various consultants and specialists. None of these could explain the condition, although one contributed the helpful comment that "this woman is evidently suffering from a disease we know little or nothing about." However, the articles by Lovett, in the *Journal of the American Medical Association* in 1924, and Piette, in the same periodical in 1925, are so precisely applicable to this patient's ailment that there is no doubt but what this was a case of agranulocytosis. It is of interest to observe that this condition, recognized fairly promptly and generally today, was practically unknown and unclassified ten years ago, even if still not satisfactorily explained.

PRIMARY PLASTIC REPAIR OF CRUSHING INJURY OF THE THUMB

DOCTOR CUTLER presented a man who, shortly before admission to Roosevelt Hospital on March 18, 1930, while working on a fan belt, had his right hand caught in such a way as to crush the index finger and base of the thumb. He was brought immediately to the hospital, where, after a primary cleansing of the wound, ether anæsthesia was administered and débridement done. The index finger was held in place only by a shred of skin and its amputation was inevitable. Fragments of bone representing the head of the second metacarpal were removed and the bone end rounded off. The base of the thumb was also crushed and the thumb itself lacerated. It hung loosely by a segment of areolar tissue and skin on the palmar surface. One anterior digital vessel remained undamaged in this tissue. There was a compounding fracture of the base of the first phalanx and the head of the first metacarpal was comminuted into numerous fragments. Saving of the thumb seemed practically hopeless, yet recognizing the importance of that digit in subsequent usefulness of the hand, an attempt was made to save it, as follows:

The fragments of bone representing the base of the first phalanx and the head of the metacarpal were removed and the ends of both bones rounded off with a rongeur. This procedure shortened the metacarpal by about three-quarters of an inch. Interrupted sutures were now taken, approximating the lacerated capsule of the distal part of the joint to the periosteum of the stump of metacarpal. To reinforce this, several stitches were taken in the areolar tissue about the repair and the extensor and flexor tendons were sutured. Light closure of the superficial wound was now done with interrupted sutures of silk and a drain placed down to the region of the joint. The superficial wound of the hand was similarly repaired. It was hoped by this procedure to produce, if healing occurred, either a new joint at the injured area or an ankylosis between the metacarpal and the phalanx. Twenty-four hours after the operation, the thumb was quite cold and cyanotic. Two days later the color of the thumb was somewhat restored

CARCINOMA OF THE STOMACH AFTER OPERATION

and it was a trifle warmer. The nutrition of the thumb was apparently reestablished and healing progressed in the presence of a moderate infection which caused a purulent discharge from several portions of the wound.

The man was discharged a month after his injury with some active and passive motion occurring at the reconstructed joint and with the discharging sinus leading down to that area. This discharge continued for about three months, at the end of which time the hand was completely healed, and the patient began to use it. The reconstruction proving definitely successful has enabled the patient to retain a moderate usefulness of his hand, at least to the extent of using tools and permitting him to resume work.

DR. HENRY H. M. LYLE said that one should be very conservative in treating injuries of the thumb, always keeping in mind that the thumb is the most important finger of the hand. Much can be done even if only a stump of the metacarpal bone is left. Doctor Lyle referred to several cases shown before this society in which useful thumbs have been constructed. Huguier, of Paris, performed this operation in 1852. His method and results were published in the *Arch. gén. de méd.*, vol. i, p. 78, 1874. Klapp, in 1912, described a similar procedure. Doctor Lyle performed a similar operation in January, 1913, the result of which was shown before this society (*ANNALS OF SURGERY*, vol. lix, p. 767, May, 1914, and *ANNALS OF SURGERY*, vol. lxxvi, p. 124). It was described at that time as Klapp's method. Further research of the literature, however, showed that the credit was due to Huguier.

CARCINOMA OF THE STOMACH SEVEN YEARS, NINE MONTHS AFTER OPERATION

DR. EDWARD W. PETERSON presented a man, seventy-one years of age. His father died at seventy years of age of uræmia; his mother at sixty years of "stomach trouble." Never seriously ill. Over a long period of years he has had numerous digestive upsets. In 1919 he was treated in a sanitarium for stomach ulcer. In 1923 he was operated upon for large hæmorrhoids which often prolapsed and bled. In 1924 he complained of attacks of indigestion with headaches, vertigo, nausea, diarrhœa and weakness. Although always very thin he was gradually losing weight. Examination of urine and fæces showed nothing of consequence. Stomach contents showed no free hydrochloric acid, total acidity 15, lactic acid present, numerous yeast and occasional red blood-cells.

A radiographical study of the gastro-intestinal tract made May 23, 1924, resulted in a report that there was a carcinoma involving the pars-pylorica of the stomach. The tumor was centrally located and was infiltrated in the wall a short distance above the pylorus. There was a moderate degree of gastric retention and intestinal hypermotility.

The patient was operated upon at the Post-Graduate Hospital May 27, 1924, and the findings were as follow: (1) A hard pyloric tumor of medium size, with many metastatic glands in the mesentery in the vicinity of the growth; (2) a gall-bladder packed with stones; and a large kinked appendix. A wide resection of the stomach was done, with a Billroth II posterior gastrojejunostomy. An attempt was made, too, to remove the gland-bearing tissue nearby. Also the gall-bladder and appendix were removed.

The laboratory examination of the removed portion of stomach showed on the anterior wall a large fungoid mass measuring fifty by fifty-five millimetres in diameter with an ulcerated surface. In the large omentum there was a lymph-gland measuring eighteen by eight millimetres and several smaller harder nodules. Sections of the tumor warranted a diagnosis of adeno-carcinoma of the stomach with metastasis in the lymph-glands. Chronic cholecystitis. Chronic appendicitis.

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The patient stood the operation remarkably well and for the first four or five days following his condition was good. Then it was noted that the dressing was saturated and an examination of the wound showed a profuse escape of digestive fluids. This continued for over two weeks, when the discharge gradually lessened, finally stopped, and the wound then closed. During this time the abdominal wall about the incision was badly eroded by the action of the digestive juices. The stay in the hospital was about four weeks.

A short time later, there developed considerable pain in the upper abdomen. In the absence of Doctor Peterson, the late Doctor Silleck visited the patient at his home. He re-opened the old sinus and a considerable quantity of foul-smelling, dark fluid was evacuated. Rapid healing followed and there was no further accumulation of fluid and no more leakage.

Except when there are indiscretions as to diet or alcohol, the patient's digestive apparatus functions very satisfactorily. He has had a number of stomach upsets, however. A recurrence of the malignancy was to be expected in this case, but it is nearly eight years now since the operation was performed. It is a matter for conjecture if the leakage and infection, so distressing at the time, could have had any beneficent effect in preventing a return of the malignancy.

DR. RICHARD LEWISOHN noted that age is no contra-indication to radical resection of the stomach. Most of these patients are around sixty years of age and they stand the operation remarkably well. There is another reason for radicalism in this type of carcinoma of the stomach and that is that in many instances it is impossible at the time of operation to be sure whether one is dealing with ulcer or carcinoma. Many years ago the speaker turned down a case as an inoperable carcinoma of the cardia and this man is well today, the lesion having evidently been an ulcer. That day a man was admitted to the speaker's service at Mount Sinai Hospital with a lipoma of the back who, six years ago on laparotomy, was pronounced inoperable because of a fixed carcinoma of the pyloric region. Nothing further was done to him at the time. He is well today, without any gastric symptoms. Radical cures of five years and over are very rare, but in view of the hopelessness of this condition and the failures that have followed X-ray and radium treatment, extreme radicalism is justified.

DR. JOHN A. MCCREERY remarked that it was well worth while to show a case of this sort if only to combat the general feeling of hopelessness regarding radical procedures in carcinoma of the stomach. In his experience, radical operation in cases on the borderline and over the borderline is worth while. He had one that had gone on for seven years and another for eleven years in which this operation was done with satisfactory results. In the eleven-year case operation was refused in two hospitals. Even if there is metastasis in the liver or glands the patient may get along with distinct comfort and economical improvement.

MESENTERIC CYSTS

DOCTOR PETERSON presented a woman, twenty-eight years of age, who was first seen by him in consultation with Dr. A. A. Weiss, of this city, April 10, 1930. Three or four days before she had complained of abdominal pain, which had localized in the right

ÆROPHAGIA

lower abdomen. The pain was not severe, but persistent. There was some nausea but no vomiting. Bowels, usually regular, were constipated. There was only slight elevation of temperature, the urine was negative, and a blood examination showed some increase in the total leucocytes and the percentage of polymorphonuclear cells. The patient had always considered herself an exceptionally healthy individual.

The physical examination was negative except for rather marked tenderness over McBurney's point, with some muscular spasm and resistance. In the course of the examination, however, a rounded freely movable, non-tender tumor mass was discovered, just to the right of and below the umbilicus. When questioned about it the patient said that she had known of its presence since she was sixteen years of age, but as it had never caused her any inconvenience whatever, it gave her no concern.

A diagnosis of acute appendicitis and cyst of the mesentery was made at this time. The patient entered the Post-Graduate Hospital that night and was operated upon early the following morning.

The abdomen was entered through a para-rectus (Kammerer) incision. The appendix was readily delivered and removed. The ileum was then pulled up and a tumor mass consisting of three mesenteric cysts, in the lower ileum, was delivered. These cysts were carefully enucleated from the mesentery, without any damage to the blood supply to the bowel. The openings in the mesentery were closed with plain catgut sutures. One of the cysts was opened during its removal. It was filled with thick sebaceous material. Although no hair or bone was discovered, the contents of the cyst looked typical of the usual material found in dermoid cysts.

Following operation the patient suffered considerable nausea, vomiting, and abdominal discomfort for two or three days, after which time she made an unusually smooth convalescence, and was able to leave the hospital on the ninth post-operative day. She has had no further digestive upsets and it is believed that her attacks might have been due to the diseased appendix. Her health has been perfect since the operation.

Sections of the wall of the opened cyst show a lining of necrotic material beneath which there is a zone of epithelioid cells containing occasional poorly defined multinucleated giant cells and intermingled with lymphocytes. External to this there is a layer of fibrous tissue containing abundant lymphocytes and at one place a small nodule of epithelioid cells suggesting a small tubercle.

ÆROPHAGIA

DR. FRANK S. MATHEWS presented a woman who first applied for treatment at St. Luke's Hospital four years ago. At that time the cribbing was loud and continued through practically all her waking hours. Her employers had had to assign her a position which did not bring her in contact with the public. She did not seem neurotic, had four children and was the family breadwinner. Examination revealed no cause for the complaint. One year ago she returned for treatment with the story that the cribbing had continued, that shortly after her previous examination there was added upper abdominal distress and recently a few sharp attacks of pain suggesting gall-stones. A plain plate of the abdomen showed a long gall-bladder protruding far below the liver margin and containing a number of ring-like shadows of gall-stones. At the head of the pancreas some small shadows suggested calcified nodes. At operation the gall-bladder was removed, there was a choledochotomy with exploration of the ducts and an appendectomy. One year has passed since the operation. The cribbing ceased immediately after operation and has not returned since. In several hundred gall-bladder cases, Doctor Mathews had never seen one in which ærophagia seemed to have depended upon gall-bladder disease.

DR. CARL EGGERS said he recently saw a patient with a history similar to that of Doctor Mathews' case. She was an unmarried woman, forty-four

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years of age, who had not been well for the past four years. She had attacks of ærophagia associated with slight indigestion. The ærophagia became so persistent, and the eructations of gas so loud and annoying that she had lost her position on account of it. The attending physician considered the condition a neurosis and he did not suspect gall-bladder disease until the patient suddenly became jaundiced following an attack of pain about three months before she was seen by Doctors Eggers. A flat X-ray plate showed four large faceted stones in the gall-bladder. At operation there was found in addition to these a large common-duct stone the size and shape of an olive.

AVULSION OF THE BICEPS TENDON

DR. HENRY H. M. LYLE presented a man fifty years of age, a professional acrobat. Two years ago, while doing his turn on the swinging rings, he felt a sharp pain just below his left elbow, heard something snap and fell to the ground. The following morning he was admitted to St. Luke's Hospital where a diagnosis of rupture of the biceps was made. There was the typical gap in the tendon, the retraction of the muscle belly upward, ecchymosis and tenderness over the bicipital tuberosity of the radius. At operation the tendon was found to be sheered off at its insertion. The operative problem was the attachment of the tendon to the bone as the periosteum had been stripped off. Two braided silk sutures were woven into the tendon, the free ends emerging from the fractured end of the tendon; the free ends of the suture were then passed around the bone and fastened by a timber hitch with a double tie. This tie was demonstrated before the Surgical Society in a case of fixation of fractures of both bones of the arm by the late Dr. Charles Dowd. Even on a smooth polished surface this knot will not slip.

Within one month and a half he began light work and at the end of three months he took up his act again.

DR. SEWARD ERDMAN said he had a similar case five years ago but it was not as severe because there was no rupture of the tendon but of the muscle. The patient was a lad nineteen years of age who, while playing football, made a flying tackle; he reached forward with his right hand and grabbed the runner's ankle and held on, the force of the sudden wrench tearing the inner half of the muscular portion of the biceps where it enters the lower tendon of insertion. He was treated for "Charley Horse." Doctor Erdman saw him at Christmas vacation six weeks after the injury. There was visible a lump on the inner aspect of the biceps which slipped up and down on flexion and extension of the elbow. The biceps function was weak and operation was done to repair the torn muscle. At operation, the retracted proximal stump of the torn inner half of the muscle was found to have become smooth and conical and slightly fibrosed.

During motion at the elbow, this idle muscle bundle slid up and down within its intact fascial sheath.

The muscle stump was freshened and rather readily drawn down and sutured to the tendon of insertion, and the convalescence was uneventful.

Four months later he pitched on a college baseball team, using the injured arm.

HYPOSPADIAS

DR. HENRY H. M. LYLE presented a boy six years of age. He said, "Surgeons often have been disappointed in the results of the ordinary plastic operations for the cure of hypospadias." His own results had never been satisfactory, consequently his enthusiasm for operating on hypospadias died out. He now presented a recent case in the hope of reviving flagging interest. It is a good functional and æsthetic result. Doctor Lyle called attention to the different stages in the operation: (1) The correction

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of the ventral curve of the penis; (2) the formation of the pouch and the passing of the pouch through the reflected foreskin, thus bringing the new urethra to the glans; (3) formation of the glandular portion of the urethra; (4) æsthetic touches. The strength of this operation lies in the formation of the pouch; here there is no opportunity for lateral leakage as there are no lateral sutures.

DR. FRANK S. MATHEWS expressed the opinion that when the urethra terminates at the base of the glans or close to it, that function is not sufficiently interfered with to make operation desirable. Matters are quite different when the hypospadias is complete as in Doctor Lyle's case. Many operations have been devised for the restoration of the urethra. In most of them failure comes from fistulas forming where sutures are inserted and are dependent on urine passing over the suture line. By the method which Doctor Lyle employed and in which his result is exceedingly good, there are no sutures on the floor of the newly constructed urethra and the result is a strong argument for the excellence of the operation selected and the execution of it.

EXCISION OF INTERNAL SEMILUNAR CARTILAGE

DR. JOHN H. GARLOCK presented a man, thirty-six years of age, first seen December 16, 1931.

October 14, 1931, he slipped off a wooden horse, striking his right knee and shin against its edge in such a way as to abduct the leg on the thigh. The knee swelled considerably. Was treated by baking and massage for two months. When seen by the speaker he complained of pain on the inner side of the knee, inability to walk on uneven surfaces, and the sensation of something moving around in the joint. There was no visible or palpable deformity of the knee. There was no effusion. There was marked tenderness along the anterior extremity of the internal semilunar cartilage. When the knee was abducted and adducted in the flexed position, pain was experienced in this same situation. He was operated upon December 29, 1931. A curved medial incision was made. The patella was retracted and the knee-joint exposed. The internal semilunar cartilage was found detached at its anterior extremity for a distance of about three-quarters of an inch. There was no sign of fracture of the meniscus. It was removed. The synovial membrane was considerably thickened and reddened. The external cartilage was found to be intact. There was no hypertrophy of the fat pad, and no evidence of any loose bodies. The wound was closed after careful hæmostasis, and a posterior splint applied. The latter was removed on the fourth day when active motion within the limits of pain was instituted. This was continued until the twelfth post-operative day, when the patient was allowed out of bed. He was discharged on the fifteenth post-operative day, walking with the aid of a cane. Since then he has been receiving physiotherapy. At the present time, there is normal extension and almost complete flexion, with a freely movable patella.

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DR. JOHN J. MOORHEAD read a paper with the above title for which see page 17.

In illustration of this paper Doctor Moorhead presented a woman, aged forty-three years, who had had both knees operated on at the Post-Graduate Hospital for hypertrophic osteoarthritis. The first medio-lateral arthrotomy was performed January 14, 1929. Prior thereto she had been on crutches eighteen months, dating the onset of her bilateral trouble to a fall from a ladder. At the operation bony spiculæ were removed from the articular margins of the femur and the tibia and a partial excision was made of a hypertrophic synovia. After the first operation she left the hospital on the tenth day.

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The second operation was on February 10, 1930, and the findings were almost identical and at that time she was in the hospital three weeks and two days because she developed a phlebitis. Incidentally her uterus was removed for multiple fibroids in March, 1931.

At the present time she still has some swelling of the left leg as the result of the phlebitis, but her knee-joint motion is excellent.

SECOND PATIENT.—A man, aged forty years, was injured June 15, 1931, by a twist and a fall on the left knee. A very marked swelling followed which shortly after the accident was removed by aspiration. He was first seen by Doctor Moorhead on September 22, 1931. At that time he had a very marked synovitis with extension to 165° and flexion to 90° and a marked atrophy of the thigh and calf.

Examination showed an osteochondritis desiccans located in the typical position, namely, on the mesial side of the femoral condyle. He was operated on by the speaker at the Post-Graduate Hospital October 15, 1931, at which time a plaque of bone approximately one and one-quarter by three-quarters inches was removed, leaving an excavation on the under surface of the condyle about one-eighth of an inch deep. He remained ten days in the hospital. An office note under date of October 27 showed that he had primary union with flexion to 90° and extension to 170° , with still some swelling of the joint and atrophy of the adjacent muscles. At the present time he has full extension and flexion to about 110° . He is at work and his present disability is due to the remaining atrophy.

THIRD PATIENT.—A man, thirty years of age, fell December 26, 1930, and twisted his left knee. Thereafter the joint was swollen and disabled as the result of a synovitis. This resisted ordinary treatment and on February 12, under local anaesthesia at the Post-Graduate Hospital, sixty-five cubic centimetres of clear fluid were aspirated. At this time there was considerable pain and joint restriction. There was a reaccumulation of fluid and on April 1 a medio-lateral arthrotomy was done. The findings were a fracture dislocation of the internal semilunar with a hypertrophic synovitis and hypertrophy of the subpatella fat pads. The internal semilunar was excised together with part of the synovial lining of the upper pouches of the joint and of the tabs of subpatella fat. He was discharged from the hospital April 12.

August 1, 1931, he sustained an injury to the opposite knee due to a direct blow and thereafter there was a marked synovitis which also failed to respond to treatment. He was operated on October 21, 1931. The findings were hypertrophic synovitis with hypertrophy of the fat pads, with an intact semilunar. A partial synovectomy was done with the removal of the hypertrophied tabs. At the present time he has full extension and his flexion is to 120° .

DR. ARTHUR KRIDA (by invitation) expressed his belief that knee-joint operations of this type should in general be done more frequently than is at present the case. He had operated on over 150 cases. The nature of the cases differed perhaps somewhat from Doctor Moorhead's cases, which appeared to be mainly of traumatic origin. A considerable percentage of the speaker's cases were cases of rheumatoid arthritis, and it was amazing to him in observing this pathology at operation that anything short of operation could be expected to afford relief. On the other hand in his experience a great many crippled knees of this type can be salvaged by excision of the diseased synovial membrane.

Doctor Krida stated also that he had operated for the repair of torn crucial ligaments in ten cases with perfectly satisfactory results in eight. He emphasized the fact that operation on the knee-joint is safe, that the knee-

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joint exhibits a remarkable resistance to infection and that in his series there were no major accidents.

DR. JOHN H. GARLOCK gave a short review of thirty-six cases operated on since 1924. There were thirty-four men and two women. The average age incidence was thirty-five years. Thirty cases presented injuries of the internal semilunar cartilage. There was one cyst of the external semilunar cartilage. Two patients presented thickened retropatellar fat pads. There were three instances of loose arthroliths. One patient presented extensive adhesions in the suprapatellar bursa following an old fracture of the femur with extension of the fracture line into the knee-joint. No synovectomies were performed. In two instances the Jones incision was used. In thirty-four cases the long antero-lateral incision, described by Doctor Moorhead, was used. The average stay in the hospital was fourteen days. Active motion was usually started on the fourth or fifth post-operative day. The patients were usually allowed out of bed on the twelfth day. The results were as follows:

In thirty-four cases there was return of full function. One patient presented about 30 per cent. impairment of flexion in the knee-joint. This patient was a luetic Negro who was operated upon for a torn semilunar cartilage. In the patient with a thickened retropatellar fat pad only a fair result was obtained. There were two subcutaneous hæmatomas and no infections.

The operative technic included the use of an Esmarch bandage, careful hæmostasis and an attempt to avoid trauma. No special effort was made to use the Lane technic. He said he has always felt it unnecessary to remove thickened synovial membrane in the presence of cartilage injuries; believing that following removal of the cartilage the evidences of irritation of the synovia would disappear. This seems to have been borne out by the end-results.

The speaker had not seen the need for Lane technic in operating upon the knee-joint, provided asepsis was rigidly controlled. He wondered why Doctor Moorhead had not carried further his analogy between the abdomen and the knee regarding operative technic. The abdomen seems to take care of mild contaminations and experience would seem to indicate that the knee-joint probably can do the same.

DR. HENRY H. M. LYLE referred to the case of a professional soccer player who had both internal semilunar cartilages removed in Scotland. He consulted Doctor Lyle for injury to the external semilunar cartilage of the right knee and wanted it taken out as he could not go on playing soccer. Doctor Lyle did not consider it wise to do this but yielded to the patient's insistence. This man is one of the stars in a local professional team and has played steadily for over two years although both semilunars have been removed from the right knee.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY AND THE NEW YORK SURGICAL SOCIETY

ANNUAL CONJOINT MEETING HELD AT PHILADELPHIA, FEBRUARY 10, 1932

DR. JOHN SPEESE, President of the Philadelphia Academy of Surgery,
in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

SPIROCHÆTAL (TREPONEMA VINCENTI) INFECTIONS OF HAND

DR. JOHN B. FLICK (Philadelphia) said the pathogenesis of the organisms commonly identified with "Plaut-Vincent's angina" apparently is widespread. In reviewing the literature one is impressed with the many reports of various lesions from which these organisms have been isolated. Among them may be mentioned vaginitis, middle-ear and mastoid disease, pulmonary abscess, bronchiectasis and wounds, particularly those made by the teeth of human beings.

The inciting cause of Plaut-Vincent's infection is universally believed to be a spirochæte associated with a fusiform bacillus, but other organisms are usually found in the lesions.

There is a difference of opinion regarding the relationship of the spirochæte and the fusiform bacillus. While many believe that a symbiosis is responsible for the diseased condition, others are of the opinion that the spirochæte is merely a highly differentiated form of the same microorganism. Tunnicliff¹ has carried out studies which tend to support the latter view. Topley and Wilson², however, say that the balance of evidence is definitely against the theory that the fusiform bacilli and spirilla are different forms in the life cycle of one organism. It has been pointed out by Tunnicliff and others that the spirochætes precede the fusiform bacilli in the invasion of tissues and it is thought that they are responsible for the extensive destruction which occurs.³

Hultgen, in 1910,⁴ reported what he believed to be the first case on record of a "gangrenous perionychia" due to the symbiosis of the fusiform bacillus and the spirochæta denticola:

The patient was a child of seven years brought to him because of an ill-smelling affection of her left hand which had existed for a week. On examination "the nail of the left index finger was found hanging to its bed by only a few shreds, covering a necrotic area which was surrounded by discolored pultaceous and extremely fetid tissue remnants. The upper half of the distal phalanx of the left index finger was destroyed, but the sphacelus was limited at the distal phalangeal joint by slightly irritated, reddish and moderately swollen tissues." There was similar but only slight involvement of the left thumb and slight left axillary adenitis. She had several carious teeth and her gums were not healthy. Microscopically, smears from the affected finger tips showed the fusiform bacillus and the spirochæta denticola as did preparations from the carious teeth. The girl was in the habit of biting her fingers and the etiological connection between her carious teeth and the gangrenous affection of the finger-nail beds, as Doctor Hultgen pointed out, is quite plain.

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Since 1910, a number of cases of Plaut-Vincent's infections of the fingers or hand have been reported in the literature, references to which are appended.^{5, 6, 7, 8, 9, 10, 11} Almost all of them have been due to wounds by the teeth of human beings. In 1929, Flick reported a case of gangrenous infection of the hand and forearm following a human bite of the thumb which resulted fatally.¹² Smears of the pus in this case showed spirochætes but not fusiform bacilli. There was extensive destruction of tissue in the hand and forearm and the odor was most offensive, reminding one of that which is given off in spirochætal pulmonary gangrene. Permission for amputation of the forearm was refused and the patient died sixteen days after receiving the injury.

He purposed now to report five additional cases of Plaut-Vincent's infection of the hand and to comment briefly on the disease.

CASE I. —A Negro man, aged thirty years (Pennsylvania Hospital, Out-patient Department, History No. 39,209), applied to the Pennsylvania Hospital January 20, 1930, for treatment of a human bite of his left middle finger which he had received that day. The wound, which was over the distal phalanx, was cauterized with phenol and a dressing applied. Upon his return to the hospital four days later the wound showed evidence of infection. Microscopical examination of smears of the pus showed many spirochætes and fusiform bacilli. Hot salt-solution dressings were applied and he was instructed to soak the finger daily in hot salt solution. On February 7 there was no longer any evidence of acute inflammation, but there was a bulbous enlargement of the distal phalanx and some oedema of the entire finger. An X-ray examination made at this time showed almost complete absorption of the distal phalanx, only the thin portion of the base and the ungual process remaining. The patient failed to return for observation and could not be traced.

CASE II. A Negro man, aged forty-five years (Pennsylvania Hospital, Unit History No. 16,729), applied to the Pennsylvania Hospital June 4, 1930, for treatment of a human bite of the right third finger and thumb and the left thumb, which he had received that day. The wounds were treated with iodine and a dry dressing applied. Three days later there was soreness in the right axilla. Six days after receiving the injuries the wound over the distal phalanx of the third finger was found to be necrotic and foul-smelling. In the Receiving Ward of the hospital, under nitrous-oxide anæsthesia, the finger was incised, necrotic tissue clipped away and hot salt-solution dressings applied. The patient was then admitted to the house for further treatment. Microscopical examination of smears of the pus showed suggestive spirilla forms and a moderate number of fusiform bacilli. In spite of treatment the infection progressed, there was marked sloughing of the soft tissues and a foul stench to the wound. On June 18, fourteen days after receiving the injury, Dr. Alan Parker disarticulated the distal phalanx. For a few days the infection seemed to be under control and then puffiness and fluctuation developed on the dorsum of the same finger lower down. This area was drained under local anæsthesia on June 27. Microscopical examination of smears made from the pus at this time showed fusiform bacilli only, the suggestive spirilla forms having disappeared. Hot salt-solution dressings were continued and the patient was discharged from the hospital July 14. He continued under observation as an out-patient until September 8, when his wounds were healed.

CASE III.—An Italian man, aged seventy years (Pennsylvania Hospital, Unit History No. 20,769), applied to the Pennsylvania Hospital March 17, 1931, for treatment of an infection on the dorsum of his right hand. Two days previous he had opened a small blister on the back of the hand with a pocket-knife with which he sometimes picked his teeth. He had a temperature of 99° F. Local treatment was given, he was

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instructed to soak the hand in salt solution daily and referred to the Out-patient Department. On April 4 a microscopical examination of a smear made from the pus in his wound showed many spirochaetes and fusiform bacilli. After this arsphenamine dressings were applied daily. The condition became worse, the hand was incised and through-and-through drainage instituted. April 13, he was admitted to the house and examination showed a necrotic wound on the dorsum of the hand between the second and third metacarpal bones and a corresponding wound on the palm. Both wounds were discharging foul-smelling, greenish-yellow pus, the tissues about the wounds were discolored and the hand somewhat swollen. He had an evening temperature of 100.2° F. Examination of his mouth showed a marked infection of the gums and a number of infected stumps of teeth. April 17, a swelling on the dorsum of the right index finger was incised and pus obtained. April 27, the hand having become more swollen,



FIG. 1.—Case III. Röntgenogram of right hand which was made just prior to amputation. The destruction of bone and involvement of joints is evident.

the right index finger discolored and the proximal phalanx necrotic further surgical interference was decided upon. At operation the tendons to the index finger were found to be necrotic and the metacarpophalangeal joint of that finger destroyed. The finger was disarticulated. The incisions on the dorsum and palm of the hand were enlarged but no collection of pus was encountered. The hand was soaked daily in potassium permanganate solution and in addition continuous wet dressings were used. May 13, Dr. Adolph Walkling disarticulated the right third finger. Exposure to the rays of the sun was then tried. May 21, the patient was given 0.6 grams of neoarsphenamine intravenously. Other sinuses developed in the palm and on the dorsum of the hand. The swelling increased. It was evident that the remaining metacarpophalangeal joints were involved (Fig. 1) and permission for amputation was finally secured. May 24, amputation through the forearm eight centimetres above the wrist-joint was done. The skin was closed with clips, leaving in the wound a small rubber-covered gauze

SPIROCHÆTAL (TREPONEMA VINCENTI) INFECTIONS OF HAND

drain. His temperature became normal the following day. The wound healed without infection and he was discharged from the hospital eight days after the amputation was done.

The pathological reports (Drs. George J. Righter and John T. Bauer) in this case are of interest and are herewith given.

"Three specimens were separately received for pathological examination, following successive operations—the index finger of the right hand (S. 16,433), the middle finger of the right hand (S. 16,495), and the remainder of the right hand amputated about



FIG. 2.—Case III. Photograph of right hand after amputation.

eight centimetres proximal to the wrist (S. 16,668). From these specimens approximately twenty-four blocks were chosen for microscopical study. As the pathological process was the same in each, differing only in extent, the combined description of the gross specimens and sections will be presented.

"On gross examination the hand and fingers were swollen greatly, the greatest fullness being in the hand and proximal portions of the fingers and tapering toward the tips. There was a sinus over the dorsum of the first phalangeal joint of the index finger. In both amputated fingers, encircling the ends of the tendons projecting beyond the line of excision, necrotic tissue which diminished in amount distally was seen. In

the middle finger necrosis had extended to the tendons. Very little pus was present. The osseous surface of the proximal phalanx of the index finger was roughened.

"In the hand three sinuses were present on the palmar aspect surrounded by exuberant granulation tissue. Over the dorsum of the hand were several sinuses. No healing had occurred at the site where the fingers had previously been removed. Instead, cavities surrounded by excessive granulation tissue and exuding pus were seen. The necrotic ends of the flexor tendons to the fourth and fifth fingers projected from granulating cavities. The external disfigurement, swelling and profuse granulations about the sinuses and sites where the fingers were removed are shown by Fig. 2.

"On dissection, in the depths of the hand the deep tendons to the two remaining fingers were sloughing, partly necrotic and bathed in pus. All of this continued throughout, extending proximally to the level of the transverse carpal ligament. The distal ends of the first and second metacarpal bones were necrotic, but the process did not extend to the distal ends of the ulna and radius.

"On microscopical examination the epithelial layer of the skin, except in the ulcerating areas, appeared normal. However, even the most superficial layer of the corium contained an increased number of polymorphonuclear neutrophiles and plasma-cells, usu-

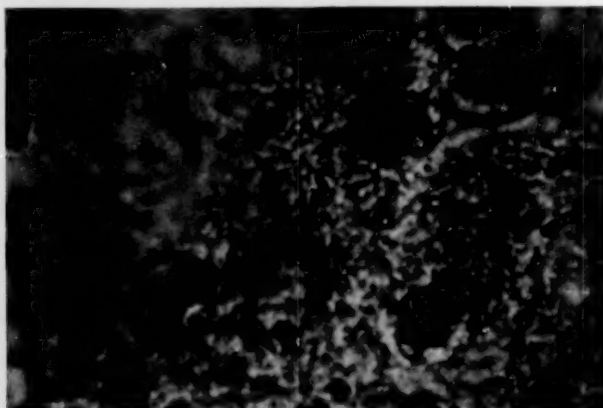


FIG. 3.—Case III. Photomicrograph of a section of tissue from right index finger under oil immersion objective, showing a typical spirochete in the center of the field.

ally scattered about the blood-vessels and cutaneous glands. Deeper in the œdematous subcutaneous and areolar tissue the infiltrating cells increased in number and became associated with fibroblasts and a few eosinophiles. Frequent small hæmorrhages were seen. In the vicinity of sinuses or superficial ulcers, the surrounding granulations were heavily infiltrated with plasma-cells and polymorphonuclear neutrophiles, which continued through the subcutaneous tissue, fat, muscle and periosteum into the bone. In the bone the osteoblasts appeared larger than usual. Usually where the osteoblasts were missing, many giant cells were seen just beyond the outer lamellæ of bone. The superficial marrow spaces were infiltrated with cells, almost as abundant as those just outside the bone, but gradually diminishing toward the depths, where an increased number of fibroblasts suggested a barrier against the invasion. However, this barrier did not prevent a moderate number of infiltrating cells from penetrating the depths of the marrow spaces, now showing the typical loose areolar structure. In the hand where the infection had progressed over a wide area, extensive necrosis of the bones, overlying muscle and fibrous tissue, devoid of infiltrating cells, was seen. The tendinous sloughs were completely acellular and gangrenous.

"Numerous microorganisms were seen. Usually in the deeper areas, beneath the

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masses of bacilli and cocci, typical irregularly curved spirochætes were present, as illustrated by Fig. 3."

CASE IV.—A Negro man, aged thirty-two years (Pennsylvania Hospital, Unit History No. 20,902), applied to the Pennsylvania Hospital April 15, 1931, for treatment of a human bite of his right thumb received on that day. The wound was treated with iodine, a dry dressing applied and the patient instructed to attend the dispensary for further care. Apparently infection was present two days later when he first visited the Out-patient Department, as wet dressings were ordered. April 22, he was admitted to the house. At this time examination disclosed a swollen and œdematous thumb. There was a tooth wound on the dorsum of the proximal phalanx which was discharging foul-smelling pus. A moderate axillary lymphadenitis was present. Proper drainage was instituted in the Receiving Ward of the hospital and hot salt-solution dressings applied. A microscopical examination of a smear of the pus showed many spirochætes and fusiform bacilli. April 29, he was given neoarsphenamine 0.3 grams intravenously. By May 11 the wounds were healed, but some tenderness and slight œdema persisted.

CASE V.—A Negro man, aged thirty-seven years (Bryn Mawr Hospital, Unit History No. 01,054), was admitted to the Bryn Mawr Hospital June 4, 1931, with a history of having lacerated his right thumb on a piece of tin in a fall while walking through a woods. This occurred May 30. The same evening the thumb became swollen and tender. He attended the out-patient clinic of the hospital, but as the infection was not responding to treatment he was admitted to the house. Examination showed a markedly swollen and tender thumb with a laceration on the flexor surface at the base of the distal phalanx which was draining thin yellowish pus. The thumb was incised and continuous hot salt-solution dressings used. Later dressings wet with potassium-permanganate solution were tried. The wound developed a foul odor, the flexor tendons sloughed and the terminal phalanx became dislocated dorsally. Microscopical examination of smears of the pus from the wound showed a great number of typical fusiform bacilli, but no spirochætes. Dr. William P. Belk, pathologist to the hospital, made a diagnosis of Vincent's infection. The patient had a low grade fever during his stay in the hospital. June 17, eighteen days after receiving the injury, amputation of the thumb was advised. The patient, however, signed a release and left the hospital.

While spirochætes were not actually found on microscopical examination in this case we have included it as a spirochætal infection because of the clinical characteristics and the finding of large numbers of typical fusiform bacilli.

Six cases of spirochætal (*treponema vincenti*) infection of the hand have been observed by us. Of these, one died from the disease, one required amputation of the hand, one amputation of a phalanx and all but one case had bone or joint involvement of some degree. One hesitates to place confidence in inferences based upon the study of a few cases. It is our belief, however, that this infection once established permeates the tissues beneath the surface, that it is prone to attack bones and joints and that it does not respond favorably to the methods commonly employed in the treatment of infected wounds. The involvement of bones and joints is not necessarily due to deep penetration of the object which produces the wound. Thus, in Case III, the infection which resulted in destruction of all the metacarpophalangeal joints except that of the thumb was introduced by pricking a blister on the dorsum of the hand with a contaminated pocket-knife. In Hultgen's case, that of a child who had the habit of biting her fingers, bone destruction occurred within a week of the onset of the infection. Here it is fair to assume that the infection was introduced through a slight break in surface continuity.

Clinically, wounds infected with the spirochæte and fusiform bacillus are characterized by gangrene of tissues and a foul odor. The time elapsing between the reception of the injury and the development of these characteristics is brief. Swelling, œdema and tenderness of the part develop as the infection progresses and later sinus formation is not uncommon. In only one of the cases observed by us, that which was reported in 1929, was the systemic reaction alarming. Pain, although present in all of our cases, was not a conspicuous symptom nor did we note severe febrile reaction.

The treatment of this condition has not been satisfactory in our experience. This in part has been due to our failure to recognize early the seriousness of the infection and to treat it accordingly. We have erred perhaps on the side of conservatism in not opening widely the infected areas at the start. A course of intravenous injections of neoarsphenamine probably should be given in cases of established infection.

Foul-smelling gangrenous affections of the fingers and hand should be studied carefully for spirochætes and fusiform bacilli. These organisms are anaërobic and cannot be cultivated by ordinary methods, but can be detected by the examination of thin smears of pus obtained from the depths of the wound.

Wounds made by human teeth should be regarded as potentially infected and so treated. Bates¹³ advocates cauterization with the electric cautery. He has treated over one hundred cases of human bites, some as late as the third or fourth day, by electro-cauterization and extension of the infection thereafter has occurred in only one case. He attributes his very satisfactory results to the immediate destruction of the primary focus of infection.

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SPIROCHÆTAL (TREPONEMA VINCENTI) INFECTIONS OF HAND

- ¹¹ Mason, M. L., and Koch, S. L.: Human Bite Infections of Hand with Study of Routes of Extension of Infection from Dorsum of Hand. *Surg., Gynec., and Obst.*, vol. li, pp. 591-625, November, 1930.
- ¹² Flick, J. B.: Gangrenous Infection of the Hand and Forearm Following Human Bite. *ANNALS OF SURGERY*, vol. xc, p. 450, 1929.
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DR. FRANK L. MELENEY (New York) remarked that he could not recall having seen a case of foul gangrene following a human bite although he had always been impressed with the seriousness of other infections resulting from such an injury. The hospital's files for fifteen years failed to reveal a similar case. This type of infection is almost certainly a disease due to a mixture or symbiosis of organisms. There has been a good deal of discussion among the bacteriologists with regard to the fusiform bacillus and the spirochæte found in Vincent's infection—whether it is a symbiosis of two different organisms or whether the spirochæte is a phase in the life cycle of the bacillus. Ruth Tunnicliff claims that she was able to see spirochætes develop in the long threads which form in old cultures of the fusiform organism. Most of the other investigators say that although curved forms occur in the old cultures of the fusiform organism, they are not true spirochætes and that in Vincent's infection there is a real symbiosis between a fusiform bacillus and a real spirochæte. Knorr, who has studied Vincent's infection in many forms, believes it to be a true symbiosis and has found that in his cultures they are always associated with streptococci. He demonstrated in his cultures that first the streptococcus predominated, then the fusiform bacillus, and then the spirochæte, as if one organism prepared the ground for the next. He believes that the infection in man is usually initiated by the streptococcus. Doctor Flick said that other organisms beside the spirochæte were always present in his cases. In practically all cases streptococci are present along with the fusiform bacilli and spirochætes. Ruth Tunnicliff saw only one case of Vincent's infection in which streptococci were not present. Varney has made careful studies and believes the fusiform bacilli to be distinct from the spirochætes. Recently, Smith, at Raybrook Sanitorium, in a study of lung infections has done some interesting experimentation on the symbiosis of the organisms found in Vincent's infection. Invariably he was able to isolate at least four different species, streptococci, of the non-hæmolytic and anaërobic types, fusiform bacilli, spirilla and spirochætes. By inoculating with pure cultures, no lesion was produced. After inoculation of various combinations of these organisms into the trachea of rabbits, all of the typical lesions which are found in chronic infections of the lung were produced—bronchitis, pneumonia, bronchiectasis, abscess and gangrene. There had to be a combination of organisms to produce any of these, and the greater the number of different species used, the severer the lesion was. Gangrene was produced only when all four species were used.

Surgeons are just beginning to have an understanding of symbiotic

infections, and are just beginning to observe that certain chronic infections are due to the presence of two different species of organisms. For example, the chronic progressive gangrene of the abdominal wall, such as has been seen following drainage of certain peritoneal abscesses, is almost certainly one of these infections. Amœbic infections are probably symbiotic. Amœbæ will not grow artificially in pure culture. Why gangrene or destruction of tissue develops when certain organisms are growing together is still an unsolved problem. It needs further study. In the laboratory certain chance observations of mixed cultures indicate that with any particular symbiotic or synergistic phenomenon—for example, the formation of gas—one organism seems to initiate the process while the other continues or finishes it. This is probably true in a destructive lesion, in which one or more species of organisms are present. These cases suggest more frequent consideration of the possibility of symbiotic or synergistic infections in all regions of the body where numbers of different species of organisms are likely to be present, such as the gastro-intestinal tract, from the mouth to the anus. For example, the very severe infections following lesions in the œsophagus, such as a diverticulum which has ruptured followed by mediastinal abscess, are well known. Peritonitis following lesions of the gut is almost certainly in this group. Lesions of the respiratory tract, from the common cold to lung abscess and gangrene, must be studied from this standpoint. In all of these instances one must consider the effect of the organisms working together in the production of the disease. Until we learn more from a bacteriological standpoint about these foul infections following human bites, we shall have to content ourselves with radical surgery, both for the prophylactic and active treatment.

DR. WILLIAM BATES (Philadelphia) said that in these virulent infections of the hand, sometimes the bacterial flora in the wound corresponded with culture from the mouth, sometimes it did not. Early in his studies, he tried to prevent spread by multiple large incisions and all types of antiseptics without influencing it to any marked degree. He found that if the periosteum was injured by the tooth that osteomyelitis and resulting amputation occurred rather promptly.

The failure to control these wounds by ordinary surgical methods led to the use of the cautery. He now anæsthetizes the patient, excises the whole depth of the bite with the cautery and leaves a sterile, painless, open ulcer to heal by granulation. He had had exceptional success since starting this type of treatment. There had been necessary only two amputations; one of these was complicated by a compound fracture at the site of the infection and the other had existed forty-eight hours before applying for treatment.

In a series of cases previously reported by other writers, it was found that hospitalization in this type of wound averaged fifty-four days, whereas in a series of 130 cases now treated early by electrical cautery, they had hospitalized only the two cases referred to as exceptions.

SPIROCHÆTAL (TREPONEMA VINCENTI) INFECTIONS OF HAND

DR. HUBLEY R. OWEN (Philadelphia) remarked that there is no type of wound which is as dreaded by police surgeons as the lacerated wound of the hand caused by a tooth. In looking up the Philadelphia police records for the past three years, he has had twenty-eight cases of this character. He routinely has examinations made for spirochætes, and has found spirochætes (non-luetic) in nine of these cases. He had previously reported three luetic infections occurring as a result of these knuckle cuts. (Fig. 4.)

Various methods of treatment, including cauterizing with the actual cau-



FIG. 4.—Chancre of hand following a tooth wound.

tery, have been employed. No method has given uniformly good results. He now treats these wounds as one treats any primarily infected wound. No improvement in results has been seen following the use of the actual cautery. Free and open drainage with rest has given the best result.

Several years ago, at a meeting of the police and fire surgeons, this type of wound was discussed. Dr. J. J. Moorhead, of New York, stated that one reason this type of infection is so frequently followed by destruction of the metacarpal-phalangeal joint with erosion of the cartilage and subsequent ankylosis is because "an injured cartilage never forgets a bruise." The cartilage, having poor blood supply, has neither the resistive power against infection nor the power of reconstruction.

All medical students and internes should be taught the danger of this

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type of wound and should be especially instructed that such lacerated wounds caused by teeth should never be sutured.

THE TREATMENT OF COMPOUND FRACTURES

DR. CALVIN M. SMYTH, JR. (Philadelphia), said that in spite of a voluminous literature on the subject of compound fractures and their management, there is practically no uniformity of opinion as to the best method of treatment and no standardized procedure for handling them in most hospitals. This is in spite of the fact that Lister made the treatment of compound fracture the basis of his original contribution to antiseptic surgery and that from Lister's time to the present the subject has been ever prominently before the surgical profession. In pre-Listerian surgery, the man so unfortunate as to sustain a compound fracture stood a very good chance of losing life or limb, through sepsis or amputation, and the former not infrequently followed the latter. The introduction of the Thomas splint brought about a striking reduction in the mortality and morbidity of compound fracture of the femur and the Carrel-Dakin technic materially reduced the incidence of infection with its immediate and remote complications. Nevertheless, it is still apparent that certain fundamental rules that should be invariably observed in this type of surgery are constantly violated for one reason or another. One fact that cannot be emphasized too strongly is that the ultimate result in a compound fracture is most often determined within the first hour of the existence of the condition and depends on what is done, or, more often, left undone by the one who sees it at that time. The physician called first is not infrequently tempted to do too much to these cases and hospital house officers to do too little. All compound fractures are operative emergencies and should be so considered. The surgery required is worthy of the best efforts of the senior members of a surgical staff and should not be delegated to inexperienced assistants. It is bad policy to allow these injuries to receive so-called first aid in accident and receiving wards and the interests of the patient are best served by postponing anything beyond temporary splinting and possibly flooding with iodine until formal surgery with adequate anæsthesia can be instituted. On this point probably all surgeons are in agreement. As to just what should be done at the formal operation there is perhaps a justifiable difference of opinion.

Experience with a fairly large traumatic service would seem to warrant the drawing of certain conclusions in this connection. First, all compound fractures should be thoroughly débrided and opened widely in order to provide adequate drainage and prevent subcutaneous pocketing. Second, the question of whether the fracture was compounded from without in or within out is one of purely academic interest and should not influence the type or extent of the operation. Third, in the desire to prevent infection, one must not lose sight of the fact that one is dealing not only with a contaminated wound but also with a fracture. No operation is complete unless the fracture

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is reduced and adequate provision made for its retention. In the vast majority of cases this can be done without adding to the risk of the patient and it also reduces the time of hospitalization—an economic factor of much importance especially in these times of depression. Fourth, the ideal operation is one which will accomplish these desiderata and in addition will not require frequent, painful and meddlesome dressings, which, of necessity, disturb the fracture. In a small group of cases seen early and where the contamination has been slight, Sherman's plan of reduction, plating and immediate closure has undoubtedly given good results. It most certainly affords every advantage to the fracture itself and does not require dressing. (Its applicability, however, is strictly limited.) Débridement followed by the insertion of Dakin's tubes in cases badly lacerated and contaminated has also given gratifying results where strict adherence to the Carrel-Dakin technic is insisted upon. In this method the wound receives the maximum attention and the fracture the minimum. The dressings are time-consuming, must be made daily and the patient must be disturbed for irrigation every two hours.

A method of treatment popularly known as the Orr method is at present undergoing a trial in a number of clinics. This method consists essentially of extensive débridement, reduction and fixation of the fragments, packing wide open with vaseline gauze and complete encasement in plaster. The original dressing is not disturbed for four weeks. In the hands of those who have used it, it has given great satisfaction, but a number of surgeons of large experience have expressed unwillingness to try it on account of real or implied dangers, although these same surgeons do not hesitate to employ it in cases of both acute and chronic osteomyelitis. The objections advanced against this form of treatment are based largely upon the danger of encasing a presumably infected wound in plaster, and particularly the danger of anaërobic infection. Experience has demonstrated, however, that this fear is not warranted by the results obtained by those who advocate the method. The speaker has personal knowledge of only one case in which gas infection developed following the Orr operation and this was in a patient seen by Dr. Fenwick Beekman and reported in a personal communication. In this instance the condition manifested itself on the third day and progressed to a fatal termination. Anaërobic infection is certainly to be considered in any injury the result of a street or a machinery accident and due precautions must be taken against it. While the incidence of tetanus appears to be on the decrease, in the Philadelphia area at least, we are seeing more cases of gas gangrene than formerly. A number of writers have drawn attention to this in the recent literature of gas gangrene in civil practice. Recognizing this danger in all compound-fracture cases, whether treated by the Orr method or not, a prophylactic dose of the combined tetanus and gas serum should be given. Before the introduction of the combined serum he employed the two separately, first using the perfringens and later the polyvalent serum. In no case had he had anaërobic infection develop. The justification for giving

serum to these cases has been questioned by some surgeons on the ground that it was unnecessary, although those who question it do not hesitate to give antitetanic serum in all street injuries. It is admitted that in many instances this is an unnecessary precaution but it would seem quite as logical to give the combined serum as antitetanic serum alone.

Others advance the argument that wounds such as commonly accompany compound fractures should be dressed in a manner permitting frequent inspection and dressing, in order that proper measures may be applied to the infection which so frequently appears. The answer to this objection is that cases treated by the Orr method do not become infected and that wound infection and osteomyelitis were more often the result of meddlesome dressings than of original contamination. When the first dressing is made at the end of four weeks, the wound and dressings are found soaked through with what at first glance appears to be pus, but which when wiped away leaves a clean granulating surface which heals promptly by granulation or in which healing can be hastened by skin grafting. Plaster is reapplied as at first and no further dressing made until union has taken place. When the second casing is removed the wound is usually solidly healed. This course is in striking contrast to that in which the daily dressings, irrigations, *etc.*, have been employed, and a very important factor is that the fracture has had the advantages of early and complete reduction and uninterrupted fixation.

He was not pleading for the employment of the Orr method in every compound fracture, for in certain cases, namely, those with extensive skin and muscle lacerations, stripping injury or cases not seen until infection has set in, it is clearly not indicated. He did, however, wish to state that in his experience with a small but constantly increasing series it has given greater satisfaction than any method heretofore employed and has been absolutely free from any of the objections brought forward by those who oppose its use. It is essentially a method of dressing rather than an operation and it is, of course, a well-established fact that no method of dressing can be a substitute for the good surgery which should precede it.

DR. JOHN F. CONNORS (New York) remarked that he had tried the Orr treatment and was not encouraged by the results. He said it may be that the fault was his own. For the past year he had used another line of treatment which he thought had given better results. Of 564 fractures, sixty were compound. The routine followed is this: Every case that comes into the hospital now is splinted on the spot where found. It is brought immediately to X-ray and then to the operating room, where the operation is performed. The wound is covered with iodoform gauze, the rest of the extremity cleaned with soap and water and then benzine. The wound is then cleaned with benzine and ether and débrided. If possible it is closed primarily. If it seems not suitable for closure, it is allowed to stay open. The results by this method are as good or better than by other methods of treatment. Of these sixty cases of compound fracture, twelve died. Of the sixty cases, thirty-two

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were of the tibia and fibula, and in these cases he had tried to make two series, giving sixteen cases to the man who advocates leaving the case open, and the other sixteen to the man who thinks primary closure is the best treatment. The results were very good except in four cases, and these were four with primary suture. He believed there is something in the Orr treatment but he has not been able to accomplish it. The simplest way is to put the bone in position when on the table, débride as thoroughly as possible, put the bones in position and apply traction.

The following are the figures on his mortality in compound fractures. In two cases of compound fracture of the radius and ulna, both developed gas infection. One was caused by a gunshot wound, sawed-off shot-gun. The other died from gas infection which developed three days after admission. One femur died twenty-one days after the accident, septicæmia having developed. There were three deaths in compound fractures of the tibia and fibula. One case died in three hours. Patient was run over by a subway train. Another case died in twelve hours. This patient has a severe evulsion with a severe comminution of two-thirds of both bones. The third case died following amputation of both legs; this patient had been pinned between a building and an automobile. In sixty cases of compound fractures seven had amputations. All patients who recovered left the hospital with union.

Doctor Connors uses no plaster bandage, but relies on traction and a supporting splint to maintain alignment.

DR. EDWARD T. CROSSAN (Philadelphia) said that on the Ashhurst service at the Episcopal Hospital they are still having good results with incision, replacing of the fragments, immediate suture and immobilization—with the exception of compound fractures of the hand. In the latter type of fracture, he thinks Orr's method is the most efficient treatment; it prevents accumulation of the extravasated products that cause fibrosis, resulting in limitation of motion. Fracture of the tibia with compounding in mesial surface will always be suitable for excision and immediate closure or a sliding flap. It may be that the fact that we do not know gas-bacillus infection causes us to continue with our method of treatment. We have seen only two cases in the last twenty years.

DR. FRANK L. MELENEY (New York) said that within the past two or three years gas-gangrene sera have been made more potent than in former years. Following the suggestion of certain bacteriologists, the biological products firms have put out serum which is potent against all of the gas-gangrene organisms as well as tetanus. There seems to be definite indication for the extensive use of this serum and a prophylactic in all cases in which there is likelihood of animal or human fecal contamination, in badly lacerated wounds and in these cases of compound fracture under consideration.

DR. FENWICK BEEKMAN (New York) said that it is a mistake to say that the treatment of compound fractures should be standardized, that is,

all cases must be treated in the same manner. This is impossible because much depends upon the type of wound and the possibility of contamination. Many fractures are produced from within out by indirect violence, the skin being broken over the angle formed by the broken fragments. He did not think in many of these cases the fragments actually pierce the skin—the latter is simply broken over it. These cases can usually be handled by cleaning the skin and wound superficially and then placing the part in a molded plaster splint or plaster case, just as in a simple fracture. Then we have the severe wound in which the fracture is produced by direct violence, the soft parts have been lacerated before the bone has been broken. These are due to direct violence. Such an injury is quite a different proposition from the first type mentioned. It is the type in which one usually sees gas gangrene. The streets of Philadelphia must be cleaner than those of New York—from what Doctor Crossan says—as we see many cases of gas gangrene in Bellevue Hospital. In the speaker's service he has about six cases a year, if not more. He would be afraid to put such injuries, fractures with wounds produced from without in, up in plaster. The case about which he spoke to Doctor Smyth a year ago was an individual with a compound fracture of the thigh, treated in one of their hospitals and débrided by a man who had had much experience during the War. The wound was then partly closed, packed with vaseline gauze, and a case applied. He died in three days from a fulminating gas-gangrene infection. In the Children's Surgical Ward a child died in two days following avulsion of the skin of the leg. The Orr treatment in chronic osteomyelitis, whether due to acute hæmorrhagic osteomyelitis or to compound fracture, has been satisfactory but he does not feel that acute hæmorrhagic osteomyelitis or a fresh compound fracture should be treated by a method which hides the wound from inspection.

DR. CLAY RAY MURRAY (New York) remarked anent the question of closing compound wounds: It is more or less a matter of betting the patient's limb or convalescence against one's judgment. Regardless of what type operation is used, one of the lessons theoretically learned in the War concerning wounds is not put into practice. In a compound fracture the sutures were placed but not tied and the wound treated for four or five days, since a great many infections do not develop until after three or four days. The wound was treated in expectation of possible infection and if it did not develop, closure was practiced.

DR. WILLY MEYER (New York) recalled the early days of antiseptics, while being assistant at Professor Trendelenburg's Clinic at Bonn, Germany. Lister's principles had just been introduced. They had swung from the use of carbolic acid to bichloride. Compressed moss wrapped in sterile gauze was the favored dressing. The moss (sphagnum) was cut from large sheets according to size required and dipped once in bichloride solution 1:1000, when it became soft and swelled up like dough. Already at that time, 1882,

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gauze was sterilized by live steam. We believed that in compound fractures it was important to investigate whether dirt had gotten into the depths of the wound. Therefore the fracture line was carefully inspected. Thorough drainage with tubes was instituted by means of wide incisions and then the wound thoroughly disinfected with bichloride, 1 to 1000, not the 1-5000 solution later on in use. Antiseptic dressing with that compound and evenly compressing moss was applied and then plaster bandages on top for proper immobilization. He remembered the joy of his chief when, after three or four weeks of not touching the wound, the first dressing was changed, while the patient had had a normal temperature. The limb was saved and the fracture went on to consolidation.

Since that time the increasing traffic in large cities, the motor cars, and later the World War, caused infinitely more cases and enlarged experience. But the general principles of treatment remained the same.

It seemed to the speaker that the proper primary inspection of the wound should not be forgotten and the patient should be brought immediately after the accident to a well-equipped hospital if that is possible. The proper care by the surgeon who attends to the wound first decides the fate of the patient.

Doctor Meyer recognized Doctor Connors' experience, and the figures he gave speak for themselves, only twelve deaths in sixty serious cases.

DOCTOR SMYTH in closing discussion said that in his own service at the Methodist Hospital and in the service of Doctor Pfeiffer at the Abington Hospital, forty-two cases of compound fracture had been treated by the Orr method. In no instance did gas gangrene develop nor was it necessary to remove a single plaster case. Doctor Smyth wished to emphasize his statement that the Orr operation was employed in suitable cases only and was not applicable to every compound fracture.

RECURRENT INFERIOR RADIOULNAR DISLOCATION

DR. ELDRIDGE L. ELIASON (Philadelphia) read a paper with the above title for which, with discussion, see page 27.

RECURRENT CALCULI IN THE URINARY TRACT

DR. ALEXANDER RANDALL (Philadelphia) presented a preliminary report of some work which he had been doing in an effort to avoid that unpleasant surgical sequence where, after the removal of a renal calculus, a recurrence rapidly follows. Of the variety of urinary concretions which we know to occur, in but one variety are we apparently approaching some understanding of its causative factors. This is the so-called earthy, or triple phosphatic stone. It has long been recognized that certain bacteria have a very limited range of chemical reaction in which they normally thrive. Today all bacteriological media are titrated to determine their pH reaction in order to successfully cultivate the types of organisms on which one is working. Change their cultural habitat in this one factor and bacteriostatic, or bac-

teriocidal, action is obtained. Surgeons have long trusted to urotropin as an urinary antiseptic and in order to insure the generation of formaldehyde, an acid medium is necessary. For this purpose, acidifying drugs are given by mouth in order to assure an acid urine. He had long felt that possibly the acidifying drugs are of greater antiseptic value than the urotropin in the dosage ordinarily administered.

There is recognized a group of organisms which have the power of breaking down urea in the urine with the formation of ammonia; the staphylococcus, certain strains of *Bacillus coli*, *Bacillus subtilis*, *Bacillus alkaligenes* and the *corynebacterium Thompsoni* are characteristic of this group. They create an alkaline urine by their ability to split urea and having created their ideal habitat, thrive therein. With the formation of an alkaline urine, there is a resultant precipitation of the alkaline inorganic salts of calcium, magnesium and ammonium, of which the characteristic phosphatic calculi are formed. Herein we have a clear insight of this probable etiological factor. Such phosphatic calculi have three characteristics: First, they are the most rapid growing form of stone seen; secondly, once their deposition starts, it is rarely superseded by the precipitation of other urinary salts; and thirdly, it is this variety of stone which the chronic stone producers and repeaters form.

In order to control this chemical change in the urine favorable for bacterial growth and phosphatic precipitation, he had carried out the following steps in his clinical material in an effort to obtain a prevention of the infection by changing the chemistry of the urine, and in so doing creating a habitat in which bacteria responsible for the same will not grow.

The first step was in the treatment of suprapubic fistulæ following cystotomy with subsequent drainage. The picture is familiar to all of the post-operative prostatic, whose wound breaks down, creating a surgical menace that is a marked detriment to normal healing and closure. These wounds appear to be essentially related to an alkalization of the urine, and at their worst present an ugly, sloughing gangrenous sore on whose walls and even on the abdominal skin there is likely to be deposited encrustations of phosphates. Some time ago we experienced the ease with which such encrustations could be removed—in fact, dissolved by the topical application of a 5 or 10 per cent. phosphoric-acid solution. The response in healing following such local treatment is marked; a healthy wound rapidly follows the separation of the ugly slough, with the complete disappearance of phosphatic encrustations. Even in the absence of such breaking down of the wound, an ammoniacal order appearing in the dressings to the initiated is a warning that trouble is in store. Since adopting this step, the handling of such cases by the topical application of this weak acid solution has become gratifyingly improved.

The second step in the clinical handling of these cases was in certain patients where, though the wound was saved from the threatened breaking down, nevertheless, the constant threat of such a possibility was evident in the persistent pool of alkaline urine draining from the bladder. No amount of acidifying drugs by mouth appears to be sufficient in these cases to change

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the reaction of such an alkaline urine to an normal acidity, while topical applications to the fistula orifice fails of sufficient penetration. It was in such a case, some time ago, that he first attempted a direct irrigation of the bladder cavity with a solution of 1 per cent. phosphoric acid. The bladder not only tolerated this solution without discomfort, but a 2 or 3 per cent. solution could likewise be used without marked irritation being experienced by the patient. Such an irrigation caused a prompt return of normal bladder urinary acidity, and this once obtained, was easily held by the administration of the acidifying drugs by mouth.

This improvement in the handling of these cases has since become a routine step in all his suprapubic cystostomies, and he felt it to be a definite step in advance in controlling the possibility of post-operative infection with the type of organism which is recognized to have the above characteristics of both alkalinizing the urine and causing a precipitation of the earthy phosphates.

This finding naturally led to the third step in attempting to accomplish the same end in cases of recurrent calculi in the upper urinary tract. As stated before these stone repeaters practically always form phosphatic stones, and with this in view, he wished to report three cases in which he had irrigated the renal pelvis post-operatively with phosphoric-acid solution in an effort and hope that by so doing the prevention of infection with the organisms which have the above-described characteristics might be avoided, and if avoided, be a means towards the prevention of recurrent calculus disease in the upper urinary tract:

Doctor Randall then threw on the screen the X-ray studies of three cases.

The first patient had had a right nephrolithotomy and left ureterolithotomy performed by the late Dr. John B. Deaver. In July, 1930, a third operation, a right ureterolithotomy, was performed by Doctor Randall. Eight months later another large stone was found and subsequently removed from the right ureter. This patient received irrigations to the renal pelvis through his post-operative drainage tube and subsequently continued to have cystoscopical lavage of this right kidney and ureter with a 1 per cent. solution of phosphoric acid. February 8, 1932, the pH of his right pelvic urine was found to be 6.1.

The second case had a stone removed from his right kidney pelvis in November, 1931, subsequent to which the renal pelvis was irrigated on alternating days with either a 1 or 2 per cent. solution of phosphoric acid over a period of ten days, and his follow-up treatment continued as in the previous case. The pH of his right pelvic urine on February 8, 1932, was 5.2.

The third case had been operated on for an acute blockage of the right ureter, in September, 1928; and a second and third operation performed on the left renal pelvis, for stone, in July and August, 1929. A fourth operation was performed upon the right ureter for an acute blockage by stone in May, 1930. An observation by X-ray study, in November, 1930, showed minute calculi in both renal pelves; while ten months later, in September, 1931, each kidney pelvis was filled with typical coral calculi. This patient sustained a fall from horseback in November, 1931, and five days later developed an acute blockage of the right ureter, necessitating a fifth operation. X-ray studies following this fall when compared to the studies made two months prior demonstrated a fracture of the coral calculus in the right kidney pelvis, a fragment of which was

causing this acute blockage. At the last operation, a ureterolithotomy, pyelolithotomy and a nephrolithotomy were performed. For three weeks following this operation the right renal pelvis was irrigated on alternate days with a 1 per cent. phosphoric acid. The wound closed promptly on withdrawal of the drainage, and the plate taken on December 12, 1931, showed the absence of any calculi in the upper right urinary tract. It was further reported that continuation of pelvic lavage at ten- to fourteen-day intervals since the last operation has been maintained, and the pH of the right pelvic urine January 28, 1932, was 5.8, and the urine perfectly clear.

Experiments on dogs' kidneys have been performed by injecting through the ureter from a laparotomy incision a 1, 3 and 5 per cent. phosphoric acid. One kidney was removed immediately, and the second one removed at the end of forty-eight hours. He had not been able to demonstrate, on microscopical study of these experimental dogs' kidneys, any evidence of damage to the pelvic epithelial lining or the renal papillæ; nor is there any evidence in these sections of any caustic action from the use of the drug in the above strengths. He summarized his remarks as follows:

(1) Phosphoric acid 1 per cent. has an equivalent pH acidity to $\frac{10}{N}$ HCl, or approximately a pH of 1.5. Its bacteriocidal value is based thereon.

(2) Phosphoric acid 1 per cent. is practically isotonic and is approximately equivalent to a gastric acidity of 100.

(3) In experimental dogs, renal pelvis injected with 1, 3 and 5 per cent. phosphoric acid fail to show any destruction of pelvic lining epithelium, or damage to the renal papillæ.

(4) Three patients in whom renal pelvic lavage with 1 and 2 per cent. phosphoric acid solution has been used, either through post-operative drainage tube, or through ureteral catheter, have not experienced excessive renal pain or discomfort. The bladder is less tolerant than ureter or kidney pelvis, and the urethra the least tolerant of all.

(5) The renal pelvic urine in the above three recorded cases has recently been restudied and found to be pH 6.1; pH 5.2 and pH 5.8.

(6) This step in treating cases of recurrent renal calculi has a rationale in both co-related conditions in the lower urinary tract and in bacteriological findings.

CONCLUSIONS.—(1) By bladder lavage with phosphoric acid post-operatively, alkalinization and phosphatic encrustations can be prevented.

(2) The treatment of staphylococcic cystitis, encrusting cystitis, leucoplakia and allied conditions by this means is indicated.

(3) The prevention of recurrent renal calculi of the phosphatic variety is being attempted with every indication of success.

(4) The possible dissolution of small phosphatic calculi, or fragments left at operation, may be expected by the recognized action of such strengths of phosphoric acid *in vitro*, and the tolerance to such topical applications *in vivo*.

DR. EDWIN BEER (New York) remarked that some years ago, the surgeon was satisfied with removal of the kidney stone or stones, and instructing the

RECURRENT CALCULI IN THE URINARY TRACT

patient following the operation to abstain from certain dietaries. Experience has shown that the situation is not as simple as this. The more kidney-stone cases one sees (in the last ten years we have had over 1,500 kidney- and ureter-stone cases), the more difficult it becomes to evaluate the factors that make for recurrence; and the more carefully cases are studied post-operatively, the greater the number of recurrences observed.

Before analyzing the problem, however, we must distinguish between real bona fide recurrences and false recurrences due to overlooked smaller or larger fragments, which have been allowed to remain in the kidney following what appeared to be a complete surgical evacuation. About thirty years ago, a similar discussion concerning gall-stone recurrences was carried on in medical literature, when the distinction between true and false recurrences was emphasized.

With the modern development of the surgery of kidney stones controlled by X-ray of the exposed kidney in the operating room, it has been possible to empty the kidney more completely than before this procedure was introduced. Fluoroscopical control of the exposed kidney has proven less satisfactory than photography on a small film with an intensifying screen. This objective control of the exposed kidney assures the surgeon as to whether all calculous material has been removed, and if there is any doubt, or sand has been encountered in the kidney during the removal of stones, the kidney can be drained either through the pelvis or through a nephrostomy to permit of subsequent discharge of these particles which may prove to be nuclei of subsequent new stones.

In addition to this control in the operating room, before discharge from the hospital, it is customary to take a series of flat pictures to confirm the operating-room findings. Unless all stones or fragments of stone are removed, unless one is sure one has emptied the kidney, a discussion of the incidence of true recurrences is of questionable value. If, however, all stones as controlled in this manner have been removed, and the kidney in the course of a few months, or years, develops a stone, then only can we consider that we have a true recurrence. In our experience, a solitary stone in the pelvis removed by pyelotomy is much less frequently followed by recurrence than those complicated stones usually associated with sand that are more or less dendritic in their structure, filling the pelvis and one or more calices, whether single or multiple. In this our experience is at variance with some other clinics, where more recurrences have been seen after simple single stone removal by pyelotomy than after the more complicated dendritic calculi. The factors underlying stone formation are fairly well evidenced in a number of organs of the body. Apparently, even without infection, stones may crystallize out of the fluid in which the chemical salts are present, and if stagnation is present, it favors this crystallization and deposition of salts. Apparently, in both the bile and in the urine, the salts, particularly cholesterolin and uric acid, are present in a supersaturated condition, and are held in solution by colloids. If one allows such acid urine which contains an excess of uric acid

to stand in a test tube, in the course of one to three days one can see frequently the colloidal nebecula separate from the urine and coincident with this the uric-acid crystals are thrown out and are deposited on the test tube. Similarly, in phosphaturia cases, the phosphates are thrown out as a lipid colloid which collects on the top of the urine in the test tube. In prostatic obstruction with clear urine, there is frequently a tendency for urates to sediment out in the residual urine and stones apparently form as a result of this process; similarly, in the gall-bladder as a result of similar physical chemical changes, cholesterin stones develop.

If infection sets in, a totally different type of stone forms in both the urinary tract, kidney or bladder, or in the gall-bladder. In the above observations in the urinary bladder, stagnation of urine seems to be the clue to the formation of stones, and it is very likely that a similar stagnation in the kidney, both pelvis and calices, may contribute to the formation of primary uric acid, oxalate or phosphatic stones in this region. In the face of infection, stones of earthy phosphates are most likely to develop in the kidney, and it is our problem to control both the stagnation and infection in the kidney, if recurrent stones are to be avoided.

It has been my experience that in the lowest calyx, perhaps due to man's upright position, stones seem to form more frequently than in the other calices, either as primary calyceal stones or as extensions from a pelvic stone. If such a calyx becomes distorted and dilated, one can readily understand that stagnation in this calyx will persist and recurrence will probably develop even if little or no infection be present.

Dietary measures in controlling recurrence of kidney stones seems to be of very little value if deformity of the kidney and poor drainage are not controlled. Uric-acid calculi, which are present in between 6 per cent. and 10 per cent. of all cases, probably can be controlled by dietary measures. Phosphatic primary stones possibly can be controlled by making the urine highly acid. Oxalate stones cannot be prevented with any regularity by a low oxalate diet, though it is well worth while advising the patient to avoid foods rich in oxalates. Cystin stones also are hard to control, though some reports have suggested that alkalinization may prevent reformation after removal of such stones. Recurrent stones in infected kidneys are much more difficult to control; even with pelvic lavage using antiseptics one cannot with any regularity control reformation.

At operation, however, one must establish free drainage from the kidney, and if it is possible, having found a dilated calyx, for instance in the lower pole, one should obliterate this pocket, either by using mattress sutures or by resection of the lower pole if the calyx is very large. Whether nephrostomy with irrigation is of value in preventing recurrence in these infected cases is highly doubtful. It does seem more advisable to rely upon natural diuresis and forced fluids to attempt to wash out the kidney cavity than to rely upon an occasional irrigation through the cortex or through the ureter catheter.

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In some cases, however, in which much sand has been encountered, post-operative irrigation of the kidney through the nephrostomy tube with weak antiseptic, especially with hydrochloric or acetic-acid solution may dissolve some of the earthy phosphates and thus delay recurrences.

From these remarks it is evident that the problem is by no means simple and some writers have made the outlook a little more problematic by claiming that a vitamin deficiency underlies the whole process of stone formation. Whether this vitamin deficiency manifests itself in the above-mentioned colloidal instability or not has not been demonstrated, but it would not be surprising if such a colloidal instability resulted from either physico-chemical or dietetic disturbance.

In connection with Doctor Randall's experiments with phosphatic deposits following cystotomy operations, our experiences have been very much the same. These are difficult to control unless the urine is acid, and we have found that the best acidifier of the urine is ten grains of boric acid and sodium benzoate with ten grains of urotropin, to which ammonium chloride can be added as required. In addition in some of the more obstinate cases, hydrochloric acid and acetic acid up to 1-1000 or Gouley's solution or normalactol have been used with considerable success. In passing, I would call attention to the publication in the *Presse Medicale* by Meyer, in 1925, in which he calls attention to the fact that the secondary stones in the bladder can be dissolved by irrigations with the above types of acid solutions.

In the upper urinary tract, we have tried to dissolve out such stones by using a Murphy drip, double flow ureter catheter, and instilling gallons of the acid solution. No stones of any size have been dissolved in this way, though these various solutions in test tubes within one to two days usually dissolved even fair-sized calculi of the group under discussion. Small calculi and sand particles undoubtedly can be dissolved in the upper urinary tract by these methods, and, in fact, von Haberer about two years ago claimed that he regularly used normalactol, which is a lactic-acid solution with a buffer in all complicated stone cases to dissolve out residual fragments.

His experience is not quite as encouraging as Haberer's publication might suggest. On the whole, this is a new field, and he felt that with more intensive work along the lines suggested by Doctor Randall and in his remarks, eventually they will be able to do something very definite for these patients, not only in relieving stagnation and infection, but in changing the renal condition by various irrigation methods, which will dispose of stones before they get to be large recurrences.

DR. LEON HERMAN (Philadelphia) said that Doctor Randall's presentation is in the nature of a preliminary report, and, as he understands it, he does not mean that his analysis is the final word on the therapeutic value of phosphoric acid in the treatment of phosphatic urolithiasis. With this reservation, it would seem that this method of treatment, especially its prophylactic use after operation, has great advantages over prior methods. The speaker

questioned the justification for the routine use in phosphatic calculi in the kidneys. The modus of its action seems not to have been discovered, but it is well known that phosphatic stones occur only in the presence of infection, chiefly of the coccal types, and it might well be that local changes occur as the result of the action of phosphoric acid, which render the medium unsuited to bacterial life. Hexylresorcinol is extremely useful in the post-operative period, especially in the surgery of the lower urinary tract, its benefits being derived from the control of coccal infections. It will be interesting to observe the effects of phosphoric-acid irrigations of the kidney in those cases in which a nephrostomy tube is employed. Certainly the use of phosphoric acid as suggested by Doctor Randall is a decided forward step in the therapeutics of an extremely annoying condition.

REDUNDANT GASTRIC POLYP—GASTRIC MUCOSA PROLAPSE

DR. DAMON B. PFEIFFER reported the case of a woman, aged sixty-five years, who was admitted to the Lankenau Hospital November 3, 1931, complaining of a lump in the right upper quadrant of her abdomen.

She was well developed, not emaciated; blood-pressure 180/26; the heart and lungs negative to examination; a lipoma, size of a lemon, in left breast; hæmoglobin, 65 per cent.; erythrocytes, 3,350,000; leucocytes, 6,800; Wassermann and Kahn, negative; icterus index, 5, Van den Bergh indirect, faintly positive direct negative; coagulation time 6.5 minutes; bleeding time, 8 minutes.

A rounded mass, the size of a large cocoanut, could be felt in the right upper quadrant of the abdomen, coming down from under the costal margin. It was smooth, symmetrical and was continuous below with the palpable edge of the liver, with which it moved on respiration. Gastro-intestinal X-ray showed the stomach displaced downwards and to the left; pyloroduodenal canal deformed and a defect in the shadow in pyloric region attributed to pressure. The cholecystogram showed a defective shadow which diminished, however, with fat meal. Barium enema showed only irritability of colon.

Under a diagnosis of hepatic tumor, cyst or abscess, she was operated upon November 11, 1931, under spinocaine anaesthesia. The mass proved to be a large, yellowish-red tumor of the liver, at first glance solitary, but on closer examination smaller nodules were found above the mass but in immediate relation to it. No other nodules were present in the left lobe or in the remainder of the right lobe. It was resilient and numerous blood-vessels coursed over its surface. It was thought to be an inoperable hæmangioma. A nodule about 1.5 inches in diameter was then observed in the gastrocolic omentum. There was no glandular enlargement in the neighborhood. On palpating the body of the stomach a movable mass was felt within the stomach, evidently a polyp. The nodule in the gastrocolic omentum was easily removed. By gastrotomy a polyp two inches long, swinging from a small soft pedicle, was seen. The stomach wall was apparently normal but the body of the polyp was friable. The polyp was excised at the base and the operation concluded with the intention of submitting the tumor of the liver to radiation. However, the patient died on the third day with symptoms of basal bronchopneumonia. No autopsy was permitted but a specimen of the tumor of the liver was removed which was pronounced metastatic carcinoma. The body of the gastric polyp was carcinomatous. The nodule in the gastrocolic omentum resembled the carcinomatous polyp in structure. The case is remarkable pathologically in that the malignant changes in the polyp did not involve the base or adjacent stomach while only two metastases were demonstrable, one in the gastrocolic omentum, evidently lymphatic-borne, while the liver metastasis must have been hæmatogenous.

REDUNDANT GASTRIC POLYP—GASTRIC MUCOSA PROLAPSE

He presented this case because of the increased interest in polypoid growths in general and gastric polyps in particular. If one excludes fungating or simple protuberant benign or malignant tumors, it would appear that true polyps of the stomach are rare. In the Obuchon Krankenhaus there were only four cases in 7,500 autopsies. Tilger found fourteen cases in 3,500 autopsies. They occur as (1) single or several discrete pedunculated tumors, or (2) as more or less widespread areas thickly beset with polypi (generalized polyposis or polypoidosis), or (3) as coalescent papillomatous tumors surmounting hypertrophied rugæ (polyadenoma en nappe of Menetrier). The last variety is exceedingly rare. Polypoidosis is a somewhat more com-

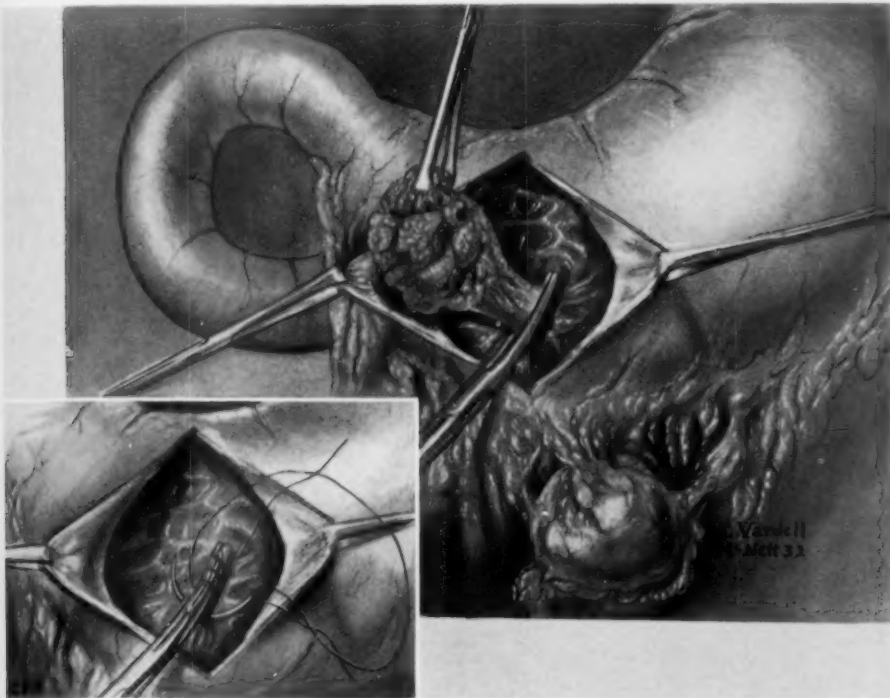


FIG. 5.—Gastric polyp and omental metastasis, overhanging mass in liver not shown.

mon condition and exhibits a strong familial tendency. Solitary polyps are more often found and may be adenomatous or simply polypoid fibroma, myoma, cyst or angioma. The chief dangers are hæmorrhage and malignant change. Bleeding is common and may be massive or small repeated losses bringing on profound anæmia. All patients with unexplained anæmias should be X-rayed with this possibility in mind.

Adenomatous polyps are prone to become carcinomatous. The symptomatology is indefinite. Tumors which prolapse through the pylorus usually cause some form of distress simulating ulcer or gall-bladder disease. Polyps of the body or fundus of the stomach are often silent. Gastric symptoms when accompanied by persistent loss of blood through the bowel may arouse

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suspicion and indicate X-ray examination, upon which a clinical diagnosis of the condition depends. The speaker had a strong impression that owing to the difficulties of recognizing such growths, they are more common than at present suspected.

In 1925, Eliason, Pendergrass and Wright collected from the literature and their own experience a considerable number of pedunculated growths of the stomach in connection with an article on the Röntgen-ray diagnosis of these peculiar tumors. In this paper they presented two cases, which they believe to have been the first reported, of prolapsing mucous membrane of the stomach extending through the pylorus into the duodenum. These cases closely simulated in röntgenological signs the more frequent condition of pedunculated pyloric polyp extruded into the duodenum. In one of these cases several polyps were present on the prolapsing mucous membrane. In the other case no polyp was present. This case also had disease of the gall-bladder and a few stones as in the case here reported. It is difficult, therefore, to construct a clinical picture because of the paucity of cases and the chance that it is impossible to separate symptoms due to prolapse of the mucosa from possible gall-bladder symptoms. In any event the diagnosis is one to be made only by careful X-ray examination and equally careful surgical exploration. In a later paper in the *Journal of the American Medical Association*, February 1, 1930, Pendergrass analyzed the X-ray appearance of this lesion as follows:

Prolapsing Mucosa.—All of the phenomena noted in pedunculated tumors are observed in this condition, and, in addition, there is a defect in the pyloric region of the stomach which varies in direct proportion to the obliteration of the gastric canal. (1) If there is a large collar of prolapsing mucosa, there will be a wide pyloric space or filling defect. (2) If only a small collar is prolapsing, there will be a less dense opaque shadow in the pyloric region as compared to the density of the body of the stomach. (3) If the amount of prolapsing mucosa is less than 1 and more than 2, the pyloric defect will consist of longitudinal striations similar to those seen in hypertrophied rugæ of the stomach or when the stomach is only slightly filled and there is some pressure on the spine.

The condition is comparable to what the urologists describe as "floating trigone" of the urinary bladder in which the mucous membrane slides downwards and may obstruct the internal urinary meatus: and to the not infrequent condition of prolapse of the mucous membrane of the anus often seen in infants with or without true prolapse of the rectum. What its frequency or significance may be it is impossible to state, but it is in order to record cases as they occur so that conclusions may be drawn.

In regard to treatment, it seemed to be simplest to plicate the redundant mucosa and secure its adhesion to the outer coats. This is the principle employed in linear cauterization for prolapse of the mucous membrane of the anus, and it is efficient. No gastroenterostomy was done in this case. The result anatomically and clinically after this short interval is perfect.

REDUNDANT GASTRIC POLYP—GASTRIC MUCOSA PROLAPSE

DOCTOR PFEIFFER detailed also the history of a man, aged forty-one years, who was admitted to the Lankenau Hospital December 14, 1931. Ten years previously he began having attacks which he attributed to gas, beginning usually about 2 to 4 P.M., and lasting until midnight. Soda, belching, or vomiting seemed to relieve, but a heavy dull pain in the lumbar region often persisted for two or three days. Pain was never severe and had no association with any kind of food. Attacks at first came on at intervals of about six months, but latterly were becoming more frequent. Aside from these disturbances, he was very healthy and well and a thorough diagnostic survey



FIG. 6.—Defect in duodenal cap due to pseudo-polyp.

revealed no organic disease. X-ray films showed no gastric pathology but a constant clear defect was observed in the first portion of the duodenum exhibiting the characteristics of a polyp, and under this diagnosis he was admitted to the hospital.

At operation, December 16, 1931, the stomach, pylorus and duodenum appeared to be normal. The appendix was kinked at the base and was removed. The gall-bladder was very slightly thickened and was removed. No stones were palpated before removal but on opening the organ a few small sandlike concretions were found. The gastrocolic omentum was opened to permit more satisfactory palpation of the stomach. In this manner a curious elusive thickening could be felt about 1.5 inches proximal to the pylorus, more marked in relation to the lesser curvature. The anterior wall of the

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stomach was incised and the duodenum and stomach aspirated free of contents. The interior of the duodenum and stomach were inspected and palpated. No polyp was present. Attention was then directed to the obvious redundancy of the gastric mucosa in the pyloric region. When grasped with Allis forceps a large fold could be picked



FIG. 7.—Normal duodenal cap after operation, evidences of gastric irritability due to plastic procedure.

up and moved freely over the outer coats of the stomach wall. It could be made to glide downwards through the pyloric ring and it was concluded that this was an instance of sliding mucosa simulating polyp by extrusion into the duodenum. A considerable fold of the loose mucous membrane was picked up, oversewed with chromic catgut and attached to the underlying coats. Convalescence was uneventful. He has re-

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maintained symptom-free and X-ray examination February 2, 1931, shows the stomach and duodenum to be normal with no trace of the previous defect.

DR. HENRY W. CAVE (New York) said that at the Roosevelt Hospital in New York, the experience with gastric polyp had been exceedingly limited. In 1902, Joseph A. Blake removed a single polyp which proved to be a benign adenoma. From 1910 to 1932, a twenty-one-year period, out of 993 operations upon the stomach, in not a single instance has there been recorded the presence of a polyp. However, recently, on the service of Dr. James I. Russell, a man of forty-five years of age presented an interesting problem.

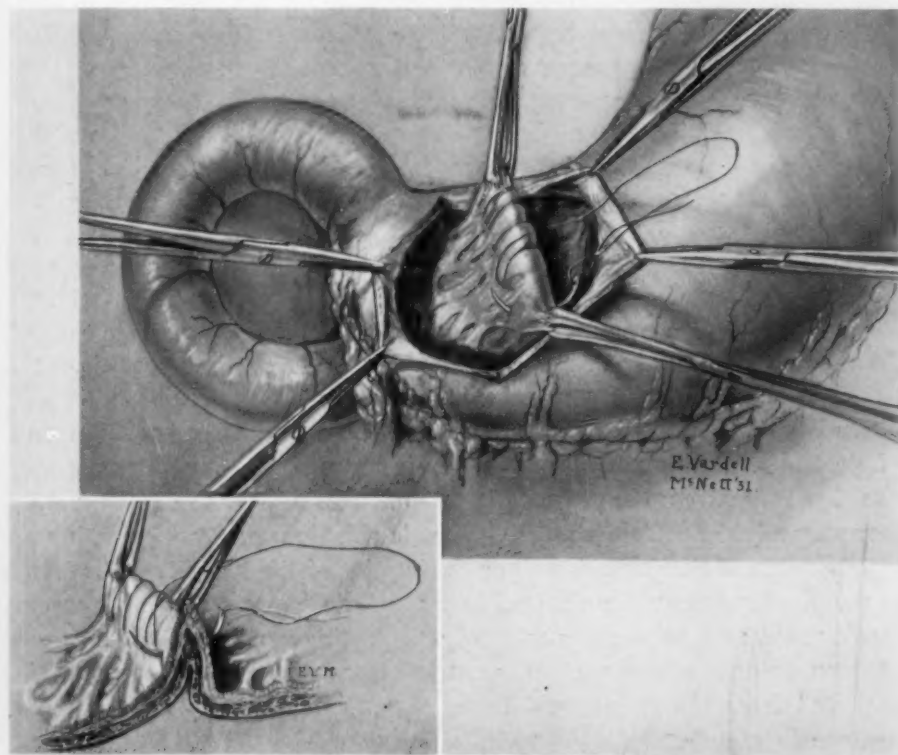


FIG. 8.—Semi-diagrammatic representation of plication of mucosa and submucosa.

This man had always been well until January 14, 1932, when he felt nauseated and vomited. Then for a period of two weeks he suffered much discomfort and cramp-like pain in the upper abdomen. He also had intermittent attacks of vomiting. X-rays showed a defect in the duodenal bulb. A diagnosis of gastric polyp was made. These intermittent attacks were thought to be due to pyloric blocking from a polyp. Twenty-four hours after admission increasing abdominal distension was noted. Flat X-ray plate of the abdomen showed a greatly distended loop of terminal ileum. The pre-operative diagnosis was new growth on ileocecal valve and possibly a gastric polyp. Immediate ileocolostomy was performed. Stomach was merely palpated, nothing abnormal

felt. Unfortunately, the man developed pneumonia and died February 9, 1932.

Considerable difference of opinion exists as to the instance of this condition. Gastric polypi and polyposis of the stomach should be clearly differentiated as they present two distinct clinical entities. Ebstein records fourteen cases of gastric polyp in 600 autopsies. Tilgen reports fourteen cases in 3,500 autopsies. Mulengracht found eleven cases in 11,475 post-mortem examinations. Stewart, of Leeds, in 11,000 autopsies found gastric polypi in forty-seven, and reported that thirteen out of 263 cases of cancer of the stomach, or 4.9 per cent., originated in polypi. Eliason and Wright, in 1925, collected 610 cases of primarily benign tumors of the stomach; fifty of these were from the University and Philadelphia General Hospitals. In 1930, these authors with Miller reported six additional cases of gastric polyp. The instance of malignant degeneration according to various authors ranges from 3.5 per cent. to 35 per cent. The etiology is unknown. It is believed frequently to be the result of chronic gastric catarrh and some think it is associated with the atrophic form of gastritis. Rokitsky, with his experience of over 30,000 autopsies, believed they were the result of inflammatory irritation, or, in some cases, congenital. Many give no symptoms; many come giving symptoms of anæmia as the most prominent feature of their illness. The polyp situated near the pylorus with a long pedicle may prolapse through the ring and cause pain, nausea and vomiting of a very severe grade. The most common symptoms are anorexia, pain, nausea and vomiting (usually intermittent), loss of weight and anæmia. There may be present symptoms of pyloric obstruction, intussusception, hæmorrhage and malignancy. In size they range from the size of a lentil to that of a fetal head. In number they vary anywhere from 1 to 300. Gastric polypi may arise from either the outer surface of the stomach wall or the interior of the stomach wall. Those in the interior are usually situated in the pyloric segment, but may cover a considerable area or sometimes nearly the entire interior of the stomach. Sherron records eighteen cases, most of them mesoblastic tumors which projected from the greater and lesser curvatures of the stomach into the peritoneal cavity.

While undoubtedly the most valuable means of diagnosis, the X-ray is not infallible. In these cases röntgenological study shows no interference with gastric peristalsis. It does show, however, usually the delay in gastric motility with retention of part of the barium meal after six hours; invariably a vacuole either in the stomach or in the duodenum is seen. Goldsmith recently reported a case where the film showed regularly a limited defect which was rounded and about as large as a walnut in the pyloric segment. A diagnosis of benign tumor, probably a polyp, was made. On opening the stomach at operation a freely movable peachstone was found, the patient having swallowed this six months previously and it could not be passed through the pyloric ring. The X-rays are of little use in cases of solitary polyp, especially

REPAIR OF CLEFT PALATE

if they do not cause mechanical symptoms or before carcinomatous degeneration takes place.

In regard to the treatment, gastrotomy is the only sure method of determining the presence of a polyp, and a gastroscope is often a valuable aid. Because of their close relationship to malignant disease, adenomata, fibromata and myxomata offer a serious prognosis and a subtotal gastrectomy should be done. Some authors insist that subtotal gastrectomy should be the operative choice in any type of gastric polyp.

DR. RICHARD LEWISOHN (New York) said that prolapse of the mucous membrane of the pylorus and secondary obstruction is rare. The first case was reported in 1911. In recent years interest has been revived by the studies of Eliason and Wight, who have undoubtedly collected a large number of cases, and in a number have made the correct diagnosis from the X-ray. The clinical pictures of prolapse of the mucous membrane and of gastric polyp are identical. Prolapse may go on to polyp formation and in some cases to secondary malignancy. The differential diagnosis is undoubtedly difficult, but it can be made.

REPAIR OF CLEFT PALATE

DR. GEORGE M. DORRANCE (Philadelphia) read a paper with the above title, for which see *ANNALS OF SURGERY*, May, 1932, vol. xcv, page 641.

DR. FRANK S. MATHEWS (New York) said that all operators must have felt the need of some operation which would displace the palate backward and allow the pharynx to be closed off in phonation and swallowing. In the Langenbeck operation, where tissues are approximated from side to side, the failure of the functional repair would seem to depend on lack of tissue in addition to the separation of tissues in the median line. Brophy insisted that cleft palate is simply a division of tissues and that there is no real deficiency. But this the speaker thought entirely erroneous. When in a Langenbeck operation a hole occurs at the suture line, it often heals completely by cicatrization, but this process still further draws the soft palate farther forward. Wandell, of Newcastle, has devised an operation with the intention of diminishing the gap between palate and posterior pharynx by bringing the posterior pharyngeal wall farther forward. The Dorrance operation seems a pretty severe one and requires multiple operations, and if infection with sloughing should occur, the disaster would be irremediable. The operation for cleft palate should be done only by those who have intimate knowledge of the anatomy of the parts, acquaintance with all the operative procedures, skill in operating and a kind of temperament which is chiefly characterized by self-control. Many otherwise good surgeons are not adapted to this kind of work.

DR. ROBERT H. IVY (Philadelphia) remarked that his personal experience with the Dorrance procedure has been limited to three cases, but he has had abundant opportunity to follow closely the work Doctor Dorrance has been doing from its inception and believes that this procedure is a very valuable

addition to the resources at our disposal in the treatment of certain forms of cleft palate.

There has been, and there still is, unfortunately, a tendency on the part of some surgeons to undertake cleft-palate operations with insufficient study of the problems involved in individual cases, and to look upon these cases as of minor importance when compared, for example, to major abdominal conditions. This is not as it should be, for failure of the first operation frequently ruins the case for a future good result, and there is surely not a more serious handicap to a person than to go throughout life with imperfect speech. Therefore, the surgeon who undertakes these cases should do so only after thoroughly familiarizing himself with the best technic available.

The von Langenbeck operation has been, and still is, regarded as the standard procedure in correction of cleft palate. In the past few years men especially interested in the cleft-palate problem have been taking stock, so to speak, and are becoming less and less satisfied with the von Langenbeck operation. A great drawback to this operation is that the lowering of the mucoperiosteal flaps in order to bring their edges together in the median line, and the detachment of the aponeurosis and nasal mucosa from the posterior edge of the hard palate necessarily create a dead space between the flaps and the bone above, leaving a broad, raw surface exposed to the nasal secretions. This creates a tendency toward nonunion, and even if complete union occurs, there is much scar tissue contracture which pulls forward the soft palate, creating insufficiency there, and preventing closure of the nasopharynx, so necessary for good speech. It has also been found that the von Langenbeck operation when performed early in life causes in some cases an arrested development of the upper jaw and irregularity of the teeth. For these reasons Doctor Ivy believes the von Langenbeck operation is going to be performed less and less often as time goes on. There is no time here to go into details of operative improvements that are gradually being substituted for the von Langenbeck operation, but he wished to refer especially to the recent book of Victor Veau, of Paris, in which the author describes a technic which he believes marks a great advance in this work. During the past four or five months the speaker has operated on fifteen cases by Veau's technic at various stages, and even with this short trial he is more than satisfied that the end-results are going to be vastly improved.

Doctor Dorrance's operation is especially adapted for primary cases of congenital insufficiency of the palate, with or without cleft, when neither the von Langenbeck nor any other technic will allow a shutting-off between the soft palate and the post-pharyngeal wall. It is also effective as a secondary procedure where the other operations, even though successful in closing the cleft in the median line, have not improved speech by reason of an insufficiency posteriorly.

DR. WARREN B. DAVIS said that he had used this technic at the Jefferson Hospital in six instances. Four of the six cases had short palates that had

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been repaired in earlier life. In two the palate was still cleft in the posterior half. The only radical difference between his method and that described by Doctor Dorrance is that in his cases the time elapsing between the two stages of the operations varied from eight to fourteen days. All of the patients were greatly improved in speech. In one case an opening in the palate just posterior to the incisor teeth persisted. A dental plate was used to cover this opening and the speaking voice is good.

CHRONIC CYSTIC MASTITIS

DR. J. STEWART RODMAN (Philadelphia) said that all physiologists are agreed that ovarian function plays a large part in breast function, and that in hypofunction particularly, but also in dysfunction, breast abnormalities are apt to arise. The work of Hitchmann and Adler, Rosenburg, Polano and Sedening, McFarland, Cheattle and Helen Ingleby amply supports such a point of view. In spite of all this work, however, two important factors still concerned him in deciding upon the proper advice to a given patient. First, when does aberrant physiology become pathology, and secondly, what is the real truth about any association which chronic cystic mastitis may have with carcinoma?

As to the first of these, he called attention to the work and point of view of Helen Ingleby in the pathological laboratory of the Woman's Medical College during the past five years. He, himself, had become a convert to the conservative ranks in so far as this disease is concerned in spite of having been raised in a radical school of thought in dealing with breast lesions in general.

Though others have shown the importance of ovarian function, to her belongs the credit of insisting that each breast lesion, and particularly the one under discussion, must be considered in the light of the known cycle of the mammary gland. The histological appearances differ considerably in the various phases that go to make this cycle.

In fact, the clinical findings also vary so that whatever else one may know about the patient, one must know whether one is dealing with the pre-menstrual, menstrual, post-menstrual or resting phase of the gland. To further complicate this matter, the histological appearances of the structures going to make up a benign solid tumor, for example, will often go hand in hand with those in the gland itself, so that what is often taken to be an added epithelial activity is in reality nothing more than what one would expect because of what is happening to the gland itself in the particular phase of its activity. Those interested in this most important part of the problem were referred to a paper by Helen Ingleby on the relation of fibroadenoma and chronic cystic mastitis to sexual cycle changes in the breast, about to appear in the *Journal of Cancer*.

There is, however, a time when in some of these instances of aberrant physiology one begins to deal with the pathological and, therefore, cannot

afford to any longer give conservative advice. It may be assumed that the same hormone which produces the harmless tissue aggressions and retrogressions of the menstrual cycle will in certain cases, usually associated with some type of ovarian dysfunction, produce locally a fibroadenoma, or, more generally, a chronic cystic mastitis. It seems to be the same process with these variations of the theme.

In so far as the second important problem is concerned, it does not yet seem settled as to what is the relationship, if any, between chronic cystic mastitis and carcinoma. It is agreed that the term "pre-cancerous" should no longer be used in describing chronic cystic mastitis. Certainly, most of those who have chronic cystic mastitis will not develop cancer, but some will. As yet he could find no certain way to distinguish between the two. The term "pre-cancerous" should, however, be abandoned because it accentuates something which does not happen as a rule. In agreeing to do away with it one must not forget to think always of the possibility of cancer. Cheatle, in his recent monograph with Cutler, on the breast, states that the condition which he calls "cystipherous desquamative epithelial hyperplasia" may go on to carcinoma, and he has been quoted elsewhere as stating that he believes this to happen in about 20 per cent. of the cases. This was about his own experience if by cystipherous desquamative epithelial hyperplasia he means that type of chronic cystic mastitis associated with cyst formation and epithelial activity, the papillary and adenomatous groups of Warren's original classification.

Just why the epithelial hyperplasia of chronic mastitis, in the majority of instances, stops short of carcinoma remains for future workers to show. The recent work of Hammett in Reiman's laboratory proving that at least one of the activators of epithelial growth is SH radical is interesting. There must be other factors involved, however, as continued stimulation by the SH radical leads always to higher differentiation of cells while carcinoma goes the other way and always represents a group of undifferentiated cells.

Clinicians, however, must, while waiting for these problems to be finally solved, have some sort of working rule to guide them in dealing with chronic cystic mastitis, or abnormal involution of the breast. In their newly found conservatism, they must not forget that "lumps" in the mammary gland do not normally belong there and that while the majority falling into this group of chronic cystic mastitis are harmless, some are not and should be removed either locally or with the entire breast. In a general way, one will be fairly safe if each of these patients whose age falls into the active sexual cycle of the gland is first placed definitely into the menstrual phase which she shows. Then allow one menstrual period to intervene and see the case again about ten days after the period, or in the middle of the resting phase. If the lump is smaller and less tender, further conservatism is justified. All lumps which do not change, or increase in size, particularly in woman over thirty-five, should then be removed. He did not often do the radical amputation on those with chronic cystic mastitis, but still does it in certain cases in

CHRONIC CYSTIC MASTITIS

women over forty where there are multiple small cystic masses in the gland, as it has been his experience so far that every now and again early malignancy is found in this type. Frozen sections are not of much value, as even the pathologists themselves admit, so that one must depend largely on his own and the pathologist's opinion of the gross appearance.

DR. OTTO C. PICKHARDT (New York) remarked that a composite, clinical picture of this lesion could be described thus: The palpating fingers examining a breast in which chronic cystic mastitis has developed would feel, usually in the upper and outer quadrants, a firm, diffuse hardness, filled with numerous shotty nodules. These nodules, which have a definite edge, form larger ill-defined lumps or tumors and are often unusually sensitive. They frequently regress or disappear and are very liable to be bilateral. Intermittent retraction of the nipple may be present. Associated axillary adenitis is by no means constant and is frequently evanescent in character. When it is present the nodes are usually tender and rather soft.

Seventy-six per cent. of the cases of chronic cystic mastitis studied by the speaker grouped themselves in the third and fourth decades, while the incidence of carcinoma of the breast is more common from the fourth decade onward. In other words, chronic cystic mastitis appears earlier in life than carcinoma.

The pathological reports of the Lenox Hill Hospital in 1927-1928 would every so often add, after a minute pathological and cellular description of this lesion, the term "pre-cancerous." On further investigation it developed that there were two distinct schools of thought on this subject—that of Bloodgood, in America, and of Cheatle, in England. Bloodgood felt that chronic cystic mastitis was an essentially benign condition and remained so. Cheatle believed it to be a "pre-cancerous" condition and hence dangerous. With the aid of Doctor Rohdenburg, Director of the Lenox Hill Laboratory, Doctor Pickhardt studied this problem from the theoretical and experimental angle and from the clinical analysis angle.

The investigators received a very definite impression that the type of woman, whatever her age, suffering from this disease, was of the decidedly active kind. They are of the "hyper" rather than of the "hypo" type, and of the alert rather than the phlegmatic. From this it is but a step to the thought that their ovaries are overfunctioning. This condition has been shown by various authors, particularly E. Laquer, C. Ancel, and Leo Loeb, to have a definite effect on the mammary gland. Ancel states: "Corpus luteum induces a proliferation of the mammary gland." Loeb states: "the mammary gland under the stimulus of persisting corpus luteum secretion grows to a considerable size and resembles in character that obtained in pregnancy." These conclusions were drawn from animal experimentation.

An attempt was made to produce chronic cystic mastitis in experimental animals by (1) continuous injections of corpora lutea substance, and (2) *a.*—Ligating parts of the breasts with catgut and silk; *b.*—Injection of a

watery suspension of Kieselguhr into the breast itself. The second part of the experiment was carried out after the animals were well stimulated with the corpora lutea material. The experiments proved that chronic cystic mastitis could be artificially produced.

The animals (mice and guinea-pigs) injected with corpora lutea and without obstruction of the ducts mechanically produced, showed stimulation of the breast without cystic distension and with but slight epithelial overgrowth. Most important, from the standpoint of chronic cystic mastitis being a pre-cancerous condition, one of the mice developed at the point of ligation a definite carcinoma which, at its edges, showed typical chronic cystic mastitis. But a second series of identical experiments yielded no further carcinoma but only chronic cystic mastitis.

The end-result of the speaker's first study could be summed up as follows:

Chronic cystic mastitis can be produced experimentally in mice and guinea-pigs. There were three elements necessary in the development of this lesion: (a) Mechanical stasis; (b) inflammation; (c) proliferative elements due to some epithelial growth stimulation, most logically a specific hormone of the corpus luteum, or graffian follicle, or both.

One animal developed cancer at the site of production.

Chronic cystic mastitis appeared to be a pre-cancerous condition.

The clinical analysis included 117 cases of chronic cystic mastitis, all operated upon; ninety could be traced.

Pathologically, they were divided into two large groups: (a) Simple chronic cystic mastitis, seventy-three; (b) pre-cancerous, seventeen.

The difference in classification between the simple and the pre-cancerous types is based on the following:

"The suspicion of possibly early malignant change or a tendency to malignant degeneration (so-called pre-cancerous) is aroused in those instances where the acini are filled with epithelial cells. Here even serial sections may not always succeed in demonstrating or excluding penetration of the basement membrane." (Rohdenburg.) Of all these, one and one only, clinically has developed into a carcinoma. This case came from the pre-cancerous group.

This case, in which apparently a pre-cancerous chronic cystic mastitis has developed into a carcinoma. February, 1929, a radical mastectomy of the left breast was performed for a tumor the size of a hen's egg. This tumor was movable and the skin was movable over it. Small axillary nodes were present. Microscopical examination of sections obtained from many different parts of the breast showed the picture of a chronic cystic mastitis—some of the ducts and acini were dilated and either lined with multiple layers of atypical cells or completely filled with these cells. Although the lesion was suspicious, there was no definite evidence of infiltrative epithelial growth. Sections of about twelve axillary lymph-nodes showed no evidence of malignancy. By December, 1930, there were well-marked supra-clavicular nodes with lymphœdema of the arm. Clinically the case is now one of carcinoma.

CHRONIC CYSTIC MASTITIS

The problem under discussion may be viewed from two separate but connected angles: the almost purely clinical angle, as exemplified by Bloodgood, and the almost purely histological angle, as exemplified by Cheatele. Taking the standpoint of the purely histological angle as the first station, the following observations appear to be in order. From the histological standpoint the diagnosis of malignancy is based upon certain deviations from the normal in the architecture of a given tissue. These deviations do not suddenly occur, but are gradual changes which may be traced step by step from the normal to the malignant. The exact point at which a malignant power is assumed by the cells is at all times difficult to determine, and is oftentimes utterly impossible. The histopathologist states that if this proliferation continues, then it seems logical to suppose that sooner or later the proliferation will become malignant. In support of this viewpoint he cites comparable changes in tissues other than the breast, *e.g.*, the prostate, where such changes are almost invariably followed by malignant degeneration. Against this are the facts that analogous types of proliferation when they occur in the appendix (carcinoids) are clinically but seldom malignant, and the fact that analogous types of proliferation as observed after the injection of Scharlach R in olive oil in animals do not behave in a clinically malignant manner.

In general, the theoretical conclusions would lead one to infer that chronic cystic mastitis is a pre-cancerous lesion.

The histological viewpoint, based as it is on the architectural arrangement of the tissue, must give way to the experience gathered by clinical observation, since clinical experience is the history not of what may, but of what does take place. As shown in the present analysis, clinical observation clearly confirms the standpoint of Bloodgood that the condition is not malignant, and that it does not appear to be the precursor of malignancy at a later date. The few cases associated with malignancy which we have observed much more nearly correspond to the normal cancer rate in a random sample of the same number of females of the general population. We would conclude from our analysis that the condition of chronic cystic mastitis belongs to the same group of proliferative tissue changes as the carcinoid of the appendix. While these bear certain histological resemblances to proliferative processes associated with the development of malignant neoplasms, they actually but seldom pass over the line and become malignant.

Finally, the clinical results as shown by the follow-up in this series, even where only a local excision has been done, are so excellent and so remarkably free from cancer that the speaker has been convinced against his original inclinations and must now feel that chronic cystic mastitis is a benign condition. If it is pre-cancerous it shows that removal in that stage is sufficient to eradicate the cells which tend toward malignancy.

BRIEF COMMUNICATIONS

REMOVING STONES FROM THE DUCTS WITHIN THE LIVER

FIVE methods of removing stones from within the liver have been advocated. They are: (1) The use of a scoop; (2) the use of forceps; (3) the use of irrigation; (4) the use of suction; and (5) incision of the liver and direct removal when the stones are near the surface.

To these methods, I would add another, namely: Stripping and compression of the liver with a hand below and above, making pressure as they are drawn toward the fissure of the liver.

The following cases will illustrate the origin of the idea and its application:

A woman, aged forty years, was admitted to the Methodist Episcopal Hospital of Brooklyn, January 11, 1932. During the two previous years she had suffered from epigastric pain, radiating through to the back, but without jaundice. Twelve days previous to admission she was seized by a similar pain, accompanied this time by jaundice.

After a few days of rest and treatment in the hospital, the jaundice disappeared and an operation was performed. A thick gall-bladder with a few stones was removed and the common duct was found to contain a column of faceted stones, extending from the duodenum to the fissure in the liver. All the palpable stones were removed by expression and the use of a scoop, but the large size of the last stones removed indicated that there must be more higher up in the ducts within the liver. Irrigation proved futile, as did further use of the scoop, so a T-tube was inserted in the common duct, and the wound closed.

Following operation, jaundice recurred and eventually death ensued. At autopsy the common and hepatic ducts were again palpated, but no stones were felt. The liver was then cut loose from all of its attachments and drawn out through the wound, end first, with difficulty and much force. There was much pressure and squeezing of the liver during this process.

As the liver was placed in a pan, four stones were found to have slipped from the opening in the common duct. As they had not been felt in the duct a moment before, we assumed that they had been expelled from the liver by the pressure.

Shortly after this experience another patient was admitted.

A woman, aged forty-five years, entered the Methodist Episcopal Hospital January 27, 1932. She had been ill for two days with pain in the right upper quadrant, vomiting and clay-colored stools. She was deeply jaundiced, her tongue was dry, her pulse was poor and she was dehydrated generally.

After eight days of treatment, with glucose intravenously and fluids in liberal amounts, her jaundice disappeared and she became a good operative risk. At operation there was found a thick-walled gall-bladder, about two-thirds the normal size, and a common duct full of stones.

The gall-bladder was removed and the duct opened and the stones expressed and removed with a scoop. Two stones were felt with the scoop up in the liver, but could not be brought down. Finally they were squeezed down by milking the liver with the left hand below and the right hand placed high up over the dome of the liver and drawn forward with firm pressure.

EXPERIMENTAL PEPTIC ULCER

The fingers behind the hepatic duct easily brought the stones down to the incision in the common duct, after they had emerged from the liver ducts. A T-tube was inserted in the common duct. The patient made a smooth recovery and left the hospital in three weeks.

A limited search of the literature has failed to reveal any report of the use of this procedure. I wish that it might be tried in further suitable cases to determine whether it is of value or not.

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A METHOD OF PRODUCING PEPTIC ULCER EXPERIMENTALLY *

MANN and I, in 1931, described what we believed to be a satisfactory method of making fistulas in the fundus of the stomachs of dogs. During several months of experimentation the results obtained were satisfactory and in accord with those obtained when animals with Pavlov pouches were used. Briefly, the method consists of making a fistula in the stomach of the type described by Mann and Bollman, and later making a pouch of a portion of the stomach drained by the fistula.



FIG. 1.—Pouch of fundus and fistula with ulcer in intestine.*

About two months after one of these pouches had been made, the animal died of pneumonia following distemper, and examination of the pouch and the fistula at necropsy disclosed a typical chronic peptic ulcer distal to the suture line in the loop of ileum draining the pouch. (Fig. 1.) Grossly, this ulcer so closely resembled the chronic peptic ulcer of man, and the ulcers which have been produced experimentally by Mann and Williamson and others, that the question immediately arose whether such ulcers would occur in a high percentage of animals following this procedure. Soon thereafter

* Work done in the Division of Experimental Surgery and Pathology of the Mayo Foundation. Submitted for publication, April 18, 1932.

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another of these animals died of peritonitis and at necropsy a perforated ulcer of the loop of ileum draining the pouch of the fundus was found. Another animal died after a gradual decrease in weight, and necropsy disclosed a large indurated ulcer with a chronic perforation through the wall of the pouch-fistula into the gastric cavity, with severe localized reaction of tissue and formation of abscess.

In many other animals evidence of ulceration was seen. Perforation with peritonitis and death are not uncommon, although it is rarely seen after the first-stage operation, when the material coming in contact with the mucosa of the small bowel is not pure gastric juice. Bleeding from the fistulous tract, even after such gentle manipulation as passage of a soft rubber catheter, is not uncommon. A few attempts to obtain Röntgen-ray and fluoroscopical evidences of ulceration have not met with success. Direct visualization of the ulcer with a small proctoscope or cystoscope has not, thus far, been very successful. Ulceration has been seen, but with difficulty.

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URETERAL OBSTRUCTION DUE TO SEMINAL VESICULITIS

URETERAL obstruction, due to seminal vesiculitis, was first observed at the operating table by Morgan, in 1902, while operating for ureteral dilatation and hydronephrosis. Young, in 1903, reported complete ureteral obstruction due to seminal vesiculitis, requiring nephro-ureterectomy, and a second case in 1923, relieved by an extraperitoneal operation.

Clinical cases have been reported by Herbst, Mark and Hoffman, Pugh, Barnett, and Von Lichtenberg.

Owing to the increasing interest in the subject during the past thirty years, in the absence of autopsy material the description of a museum specimen from the Department of Pathology of the University of Maryland, is thought worthy of publication. (Fig. 1.)

URETERAL OBSTRUCTION

The seminal vesicles extend along the ureters for two centimetres and are densely adherent to them for two-thirds of their circumference by fibrous adhesions, causing obstruction of each ureter, proximal to intravesicle



FIG. 1.—Ureteral obstruction due to seminal vesiculitis.

portion with marked dilatation of ureter and kidney pelves above the tip of the seminal vesicles.

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FECAL FISTULA AFTER APPENDECTOMY

THERE appeared in the May issue of the *ANNALS OF SURGERY*, vol. xcv, p. 704, 1932, an article by Dr. James Fairchild Baldwin, "The Prevention of Fecal Fistula after Appendectomy." Controversial points in medicine and surgery should be freely discussed. It seems to me that Doctor Baldwin places too much responsibility upon a simple procedure in technic, namely, the purse-string suture as an important etiological factor in the formation of fecal fistula. The greater part of the mortality and morbidity following appendectomies is not due, as he alleges, to the purse-string suture, but to neglected cases; whether the fault is that of the patient, the general practitioner, or the surgeon himself is not important in this discussion.

We have been teaching for many years that all exposed surfaces be peritonealized. This is exactly what the purse-string suture accomplishes. It makes very little difference whether it is used in burying an appendiceal stump, a perforation, the exposed surfaces after a hysterectomy, or a line of intestinal suture such as we find in the anastomosis of the viscera, one to another. To say dogmatically that the purse-string suture is all wrong will only lead to carelessness in operations other than appendectomy.

It has not been my experience that the inverted appendix acts as an incubator. I, too, have had occasion to open the abdomen years after I had performed an appendectomy. It was most difficult to find evidence of any reaction at the site of operation. There was never any semblance of infection having taken place, nor were there any serious adhesions. Even in those cases where I was compelled to open the abdomen upon the insistence of the patient to look for adhesions, nothing was found to account for the symptoms.

An appendiceal stump free in the abdomen will certainly be more liable to distribute infection than one that has been covered by peritoneum.

Carbolic acid is not as effective a cauterant as the actual cautery. Not the "tip of the cautery" but the flat surface of the instrument is used.

After many years of active surgical experience I have learned that it is impossible to lay down hard-and-fast rules concerning any operation, and this is no less true of the procedure of appendectomy. While I use the purse-string suture in 98 per cent. of the cases operated upon, there are exceptional cases where it should not be used. Where the appendix is bathed in a pocket of pus, where the base of the appendix is gangrenous, or where the cæcum is hard and indurated, inversion of the appendix is foolhardy and dangerous.

I have never in my experience encountered a fecal fistula as a result of the purse-string suture. The only fistulæ seen were those following perforative, gangrenous or suppurative appendices located near the head of the cæcum.

The chief objections as stated by Doctor Baldwin are: (1) That the purse-string suture consumes more time; this should not be considered when any simple appendix can be removed in four or five minutes. (2) I cannot agree that the cæcum must be mobilized to use the purse-string suture be-

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cause the suture can be performed on any cæcum with a curved or straight needle. (3) The danger of penetrating the bowel is reduced to a minimum when the needle is introduced properly and with care. I have never seen any leakage around the site of needle puncture. (4) A hæmatoma may result occasionally, but this is a minor matter, since a hæmostat and a ligature will control it. (5) I have never seen necrosis of the cæcum following a purse-string suture. (6) Post-operative adhesions are no greater after this procedure than when the appendix is left free in the abdomen. (7) Fecal fistulæ do not result from the purse-string suture, but from neglected cases of appendicitis. (8) The so-called incubation chamber of the buried stump is no more dangerous than the infected stump lying free in the abdominal cavity.

In the removal of the appendix I use the incision best suited to the case, including the McBurney incision.

MOSES BEHREND, M.D.
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OBTAINING LIVING FASCIAL SUTURES

THE introduction of the use of the living fascial sutures by Gallie and Le Mesurier¹ in 1923 marked a very important advance in the treatment of hernia caused by defect in muscle and fascia, namely: recurrent hernia, direct

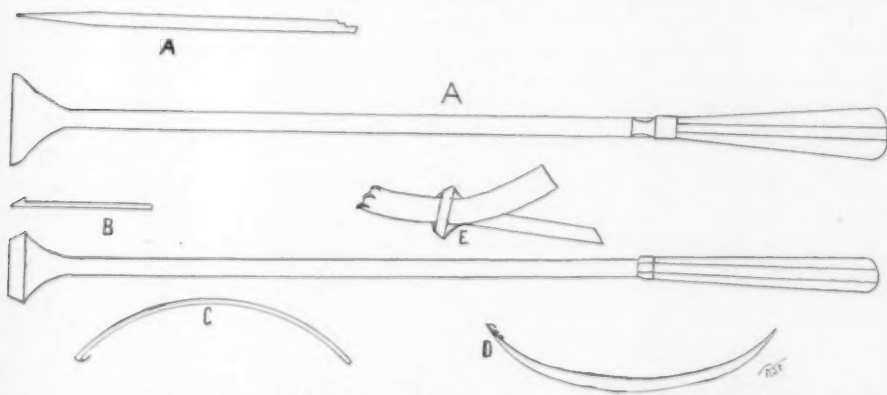


FIG. 1.—A—Fuld's fascial separator (side and top views). B—Grace's fascial stripper (side and top views). C—Fuld's fascial threader. D—Gripper end of threader. E—Threader in stripper.

hernia, ventral hernia and old oblique inguinal hernia in patients past middle age. The Gallie¹ operation, which is admittedly superior to older operative methods for these conditions, is, however, frequently refused by the patients because of the long scar which invariably results from the removal of the fascia. The Gallie operation is also accompanied by an increased period of disability, and by infection in some cases.

These objections have been largely overcome by the use of the fascial stripper devised by R. V. Grace.² Because of the density of the overlying

¹Gallie and Le Mesurier: Living Sutures in the Treatment of Hernia. Canadian Ass. Jour., July, 1923.

²Grace, R. V.: A Facial Stripper. ANNALS OF SURGERY, December, 1929.

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subcutaneous tissue, considerable technical difficulty is frequently encountered in removing the fascia with this stripper. In modifying the technic suggested by Grace, and by the use of two additional instruments (Fig. 1) which I devised, I have been able to remove the fascia more easily with the stripper and more quickly in a series of twelve cases in the past two months. A description of the method below is offered in the hope that it may be helpful to others.

Technic.—Make a two-inch longitudinal incision on the outer aspect of a thigh beginning at the level of the upper border of the patella. I prefer a longitudinal incision because the direction of the fibres of the fascia is more easily seen. Carry the incision to the fascia and dissect the latter free from the subcutaneous tissue with a scalpel about an inch on either side.

The next step is to separate the subcutaneous tissue from the strip of fascia which is to be removed. This is accomplished with the "fascial separator" which is constructed as a large-size fascial stripper but differs from it inasmuch as the cutting end is replaced by a solid piece, with an edge that is not sharp. This instrument is held at an angle of 20 degrees with the thigh along the direction of the fibres of the fascia in the plane of cleavage between the latter and the subcutaneous tissue. Now incise a strip of fascia in the line of its fibres equal to the width of the stripper and cut it transversely at the lower end where the fascia is always thicker. The strip of fascia is easily threaded in the stripper with the aid of my fascial threader. The fascial threader is a thin, half-curved steel band, half an inch wide and four inches long, and has three small teeth a quarter of an inch from its end. The teeth are engaged in the substance of the cut fascia at the lower thickened end of the strip, which is now threaded into the lumen of the stripper.

This especially designed instrument eliminates the necessity of tying knots which interfere with the process of threading the fascial sutures. It also permits the threading of the fascia in the minimum amount of time with a maximum firmness.

Remove the fascial threader and grasp the free end of the strip with a Kocher forceps. Push the stripper upward holding the Kocher forceps taut. To cut the upper end of the fascial strip, incise the skin and subcutaneous tissue longitudinally over the bulge created by the stripper in the upper part of the thigh. The stripper is then exposed and the attached end of the fascial strip is cut off. The two skin incisions are closed with interrupted silk sutures and a compression bandage is applied.

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